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ZymaX Forensics announces advanced diagnostic tool: 3D-CSIA for *in situ* remediation of organic pollutants

By Yi Wang, PhD and Greg Smith, PE

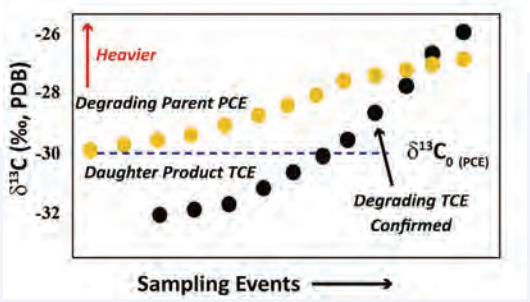
In Situ remediation, such as enhanced bioremediation, phytoremediation, permeable reactive barriers, source removal with monitored natural attenuation, is inherently considered "green remediation." *In situ* technologies, however, have a perception problem: the mechanisms of destruction are often unseen and not well understood. Further, physical affects of amendment application effect concentration data in an identical manner as the desired reactive mechanism. These uncertainties have led to the weight of evidence approach when proving viability: multiple rounds of data collection, bench studies, and pilot studies, etc. Skipping these steps has resulted in many failed *in situ* applications.

Traditional assessment data is often tangential to the desired information; e.g., "Is contaminant being destroyed or just being pushed around and diluted?" and "What is the mechanism of the destruction and can it be monitored directly?"

Compound Specific Stable Isotope Analysis (CSIA) has been recognized by the U.S. EPA as a new advanced site diagnostic tool which has an array of applications for organic pollutants, contaminated site investigation, and remediation (Hunkeler et al., US EPA, Dec. 2008).

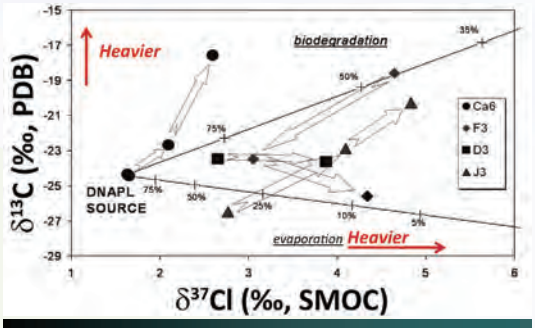
Briefly, the multiple molecular isotopic signatures of organic pollutants by CSIA can often be used to:

- provide new lines of evidence for source zone identification/cost allocation for remediation;
- unambiguously determine that *in situ* destruction of target pollutants occurring that is not concentration related;
- identify the process of remediation (aerobic or anaerobic degradation, evaporation, oxidation or reduction);
- Determine, in some cases, the rate and extent of degradation and provide a powerful predictive tool for assessing the extent and duration of contaminant plumes.



CSIA Evidence for Effective PCE/TCE Degradation
As PCE degrades, its ratios get heavier. TCE degradation is confirmed when $\delta^{13}C$ (TCE)>$\delta^{13}C_0$ (PCE)

Advanced site diagnostic tool "Three-Dimensional Compound Specific Stable Isotope Analysis" (3D-CSIA), i.e., tracing up to three stable isotope signatures of any individual contaminant (e.g., ^{13}C, ^{2}H, and ^{37}Cl of TCE), can assess viability of *in situ* technologies by providing much definitive data on contaminant destruction that is not concentration related. Use of 3D-CSIA tool allows remediation professionals to evaluate effectiveness of treatment and make better decisions to expedite site closure and minimize costs. Thus, use of CSIA allows remediation professionals to make better decisions to expedite site closure and minimize costs, consistent with US EPA's initiative for "Green Remediation."



2D-CSIA Evidence for Effective TCE Remediation
As TCE biodegrades, its carbon and chlorine ratios get heavier. As TCE evaporates, however, its carbon ratios get lighter while its chlorine ratios get heavier

Fundamental of 3D-CSIA in detail and its benefit highlighted through a series of cases studies at

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chlorinated solvent contaminated sites has been illustrated in an article in "Remediation, The Journal of Environmental Cleanup Costs, Technologies & Techniques", Winter 2010.

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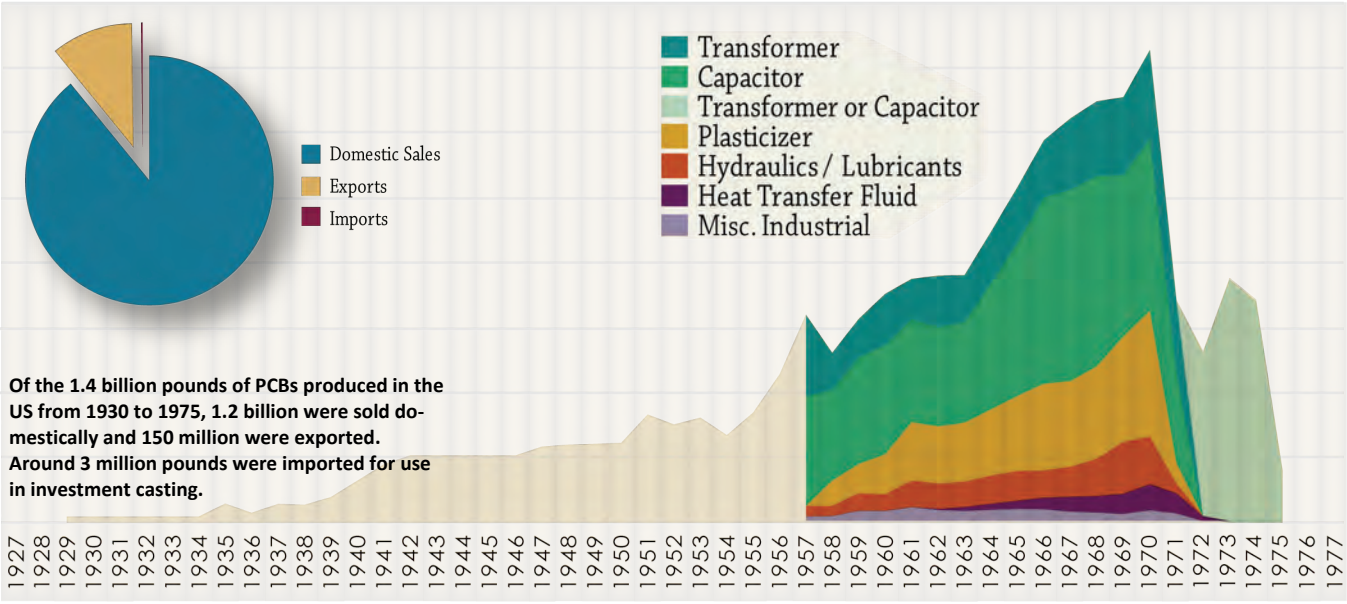
Dr. Yi Wang is the Director of ZymaX Forensics Isotope, an environmental isotope laboratory serving clients in all 50 states as well as numerous international locations. He has a B.S. in Environmental Science, an M.S. in Environmental Chemistry, and a Ph.D. in Environmental Geochemistry from Chinese Academy of Sciences, Beijing. He has worked for over 20 years in the environmental field on issues related to air, soil, and water contamination. He received his postdoctoral training on Compound Specific Isotope Analysis technology at Brown and Princeton University and applied isotope forensics in the environmental field. Dr. Wang is a geochemist utilizing carbon, chlorine, hydrogen, nitrogen, oxygen, and sulfur isotopes. He has published over 45 peer-reviewed articles and books on soil, soil, and water contamination topics and has shared this information via lectures throughout the world. He is the author of Chapter "Sampling and Analysis" in the Environmental Law Series "Environmental Science Desk Book" published by the West Group. Dr. Wang has served as an expert for the U.S. Environmental Protection Agency (EPA) and the State Coalition for Remediation of Drycleaners (SCRD) on chlorinated solvent cases where environmental forensics was used to allocate responsibility and optimize remediation strategy. Since 2009, Dr. Wang has been invited to give trainings on the 3D-CSIA Forensic Tools to regulators and consultants in U.S. EPA Regions 1, 4, 5, 6, and 9.

Greg J. Smith, P.E., P.G. is a Senior Hydrogeologist at DPRA with more than 20 successful DNAPL site closures starting with the industry's first in 1999 at the former AT&T Skokie Works in Illinois where regulatory standards were reached. Mr. Smith has also employed other remediation technologies, including in situ biodegradation, permeable reactive barriers, as well as conventional recovery methods including groundwater pump and treat and soil vapor extraction. Mr. Smith has worked with researchers at the California State University at Los Angeles, University of Illinois at Chicago and Argonne National Laboratory performing stable isotope surveys ($^{87}Sr/^{86}Sr$, ^{37}Cl and ^{14}C) to determine fate and transport of contaminant plumes in groundwater in California, Missouri, Illinois and South Carolina. Mr. Smith has provided expert witness testimony on the fate and transport of chlorinated solvents in federal court in Michigan. He has published more than 20 articles on various aspects of soil and groundwater remediation, including a chapter on *Coupled Electrokinetics – Thermal Desorption,* in a book entitled: Electrochemical Remediation Technologies for Polluted Soils, Sediments and Groundwater, and co-authored the Encyclopedic Dictionary of Hydrogeology.

A Visual Guide to PCB Production in the United States

By Ben Harris

Monsanto Production and Domestic Sales of PCBs



In 1929 The Swann Chemical Co. in Anniston Alabama began the first commercial production of PCBs. In 1935 Monsanto Industrial Chemicals Co. bought the plant and became the sole producer of PCBs in the United States until they ceased all production in 1977. These graphs combine production values from the Anniston plant with nation wide sales numbers to provide a visual representation of PCB production in the United States. The sales of PCBs in the US peaked in the late 1960s with widespread use in electrical capacitors and transformers. PCBs were also commonly used as plasticizers in adhesives, sealants and caulking compounds, surface coatings, paints, printing, and carbonless copy paper. The fire resistant nature of PCBs led to their widespread use in heat transfer and hydraulic fluids as well as lubricating oils for high temperature operations such as die casting.

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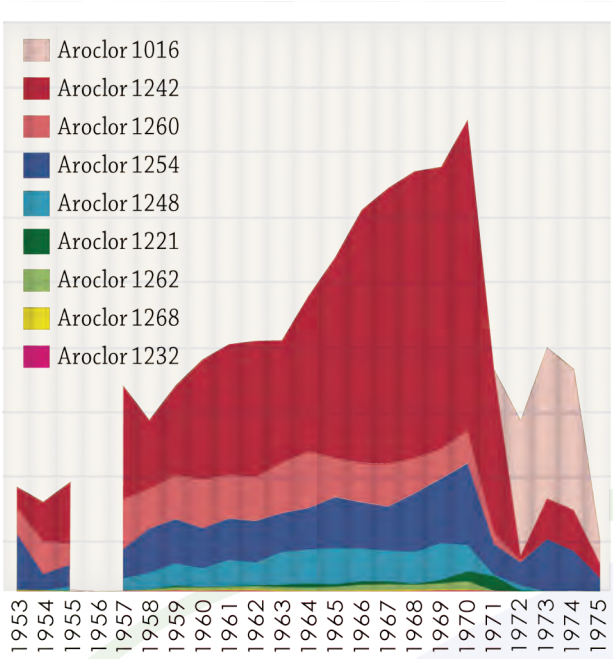
Domestic Sales of PCBs by Aroclor Type



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In North America, PCBs were marketed under the trade name Aroclor followed by a four digit number. The first two numbers refer to the number of carbon atoms and the last two indicate the percentage of chlorination. The various degrees of chlorination made the different Aroclors suitable for different applications. Some of the common uses included:

- Aroclor 1242 was used transformers, heat transfer, hydraulic fluids, gas-transmission turbines, rubbers, carbonless paper, adhesives, and wax extenders.
- Aroclor 1248 was used in hydraulic fluids, vacuum pumps, rubbers, synthetic resins, and adhesives.
- Aroclor 1254 was used in capacitors, transformers, hydraulic fluids, vacuum pumps, rubbers, synthetic resins, adhesives, wax extenders, dedusting agents, inks, cutting oils, pesticide extenders, sealants and caulking compounds.
- Aroclor 1260 was used in transformers, hydraulic fluids, synthetic resins, and dedusting agents.
- Aroclors 1016 and 1221 were primarily used in capacitors.

References:
US EPA Technical Report, Evaluation of Monsanto s Polychlorinated Biphenyl (PCB) Process for PCB Losses at the Anniston Plant, March 2005.
NIOSH, Current Intelligence Bulletin 7, Polychlorinated Biphenyls (PCBS), November 3, 1975
US Department of Health and Human Services, Toxicological Profile for Polychlorinated Biphenyls (PCBs), November 2000.

Ben Harris is the Environmental Forensics Group GIS Manager with over 6 years experience working with attorneys to "picture" the case information to maximize key arguments via trial graphics for nationally recognized Federal litigation driven assignments. He specializes in spatial analysis, data visualization, and interactive 2D and 3D data presentations.

The *Software* Side of DPRA

By Justin Hone

Did you know that DPRA has managed the largest environmental database in the world for over 20 years?
Most of our clients are familiar with DPRA as an environmental consulting firm using the latest software. But what happens when the software we need doesn't exist? Often there is no off-the-shelf product ready to handle the scope and nature of projects in which we are engaged. That's where DPRA's international software development team comes to life.

We have a long history of providing logistical support to government agencies, petroleum, and mineral companies. DPRA has maintained its leadership in logistical services by constantly creating and polishing tailored software solutions. DPRA also continues to optimize proprietary data & document management software to help us control the world's largest environmental database at the Rocky Mountain Arsenal (RMA) Superfund Site in Denver, CO.

Knowing What You Have, Where You Have It, and Who Can Access It
This may seem straightforward when it comes to successful data and resource management, but often these duties are handled by independent systems that do not communicate effectively. The Talira® software suite is built around the concept of full integration. A place where data, chain-of-command status and reporting, and real-time visualizations can be summoned under an infinite array of permissions-based logins and secure encoding, with both internal and external access capabilities. Also, each software application can operate completely stand-alone for those organizations which may not require full integration.

Talira® Mapping Services (TMS) provides customers with geographic displays showing the locations of geo-referenced data. Map displays are icon-oriented, giving the user a one-click approach to view more data or change information about a data point or tracked object. The TMS can be hosted on the web or on a client's internal network. TMS can display any spatial data in real-time.

- Mapping displays can track freight, RFID tags, vehicles, or any device that transmits its location.

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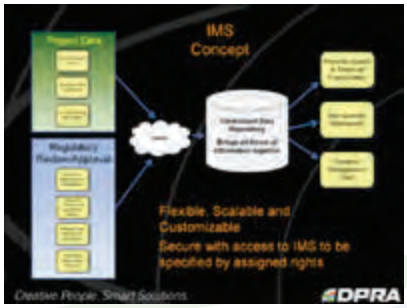
- Talira® can retrieve data from third party systems to update the locations of the freight/assets on the web-based map displays.
- Position data can be sent to different map layers, which can be turned on or off to enhance situational displays.

Document Management

Talira's® Information Management System (IMS) is a secure, collaborative, web-based system designed to manage the entire life cycle of a document. IMS provides centralized data and tools that enable digital file uploading, document sharing, information search and retrieval, real-time collaboration, analysis, and reporting.



- Manage work flow processes
- Files uploaded from various native formats and converted into searchable PDFs, while also storing documents in their original format.
- Add comments to a document, automate email notifications, and send email reminders
- Completely manages the lifecycle of document coordination
- Geographic references in documents can be linked to Talira's® Mapping Control™ providing a quick launch of the associated map for a visual reference and status.

Harvest® Monitoring and Status Reporting

Harvest® is a web-based or network-based status monitoring and reporting system for organizations of all types and sizes. Status reports can be created in real-time or according to preset schedules. Critical status changes are immediately reported.

- Real-time status reporting
- Immediate alerts for status changes
- Automated scheduled reporting
- Flexible configuration of reporting structure or hierarchy
- Web-based robustness and simplicity
- Can be linked to documents in IMS, updating status changes in Harvest® to correspond to project updates in IMS

For more information on Talira® *Information Management Systems or* Harvest® *Monitoring and Status Reporting contact* Justin.Hone@DPRA.com.

Justin Hone has been an Associate Geologist with DPRA since 2006 and received his B.S. in Geophysics from the University of California at Riverside. Since entering the environmental field in 2004, he has managed expert witness and litigation support projects, forensic site assessments, and remedial activities. He has utilized forensic techniques such as carbon isotope ratio analysis, interactive geo-spatial models, and aerial photography interpretation to investigate several chlorinated solvent, hydrocarbon, and nutrient releases. Mr. Hone's particular expertise is developing Geographical Information System (GIS) models and trial graphics to provide clients and juries with simplified concepts of otherwise complex geologic and hydrogeologic scenarios.