THOUGHT LEADERSHIP

PUBLISHED 4Q 2019

# Using Environmental Forensics to Determine Liability for Environmental Contamination

October 3, 2019

**Environmental forensic scientists combine chemical data with available documentary records (such as industrial operational information, aerial photographs, insurance maps, and witness statements) to reconstruct circumstances that led to the environmental contamination. In merging chemistry and operational history, we gain insight into what caused the contamination, when and how the contamination occurred, and the spatial extent and the fate of the contamination. Using chemical fingerprinting and other forensic analysis techniques, environmental forensic scientists can investigate a site and track contamination sources to determine liability for the response costs of addressing the contamination.**

## Chemical Fingerprinting

The goal of chemical fingerprinting is to identify unique chemical characteristics, or chemical fingerprints, that can be used to track a chemical back to its source(s). The classes of chemicals typically investigated are components of feedstocks, byproducts, and wastes that leaked, spilled, or discharged as part of industrial operations. For example, the group of chemicals called polycyclic aromatic hydrocarbons (PAHs) is found in crude oil, petroleum products, and coal tar; these chemicals are sometimes implicated in the need for a site cleanup. Other examples include perchloroethylene (PERC) and trichloroethylene (TCE, components of chlorinated solvents), chemicals that are no longer manufactured (e.g., polychlorinated biphenyls, or PCBs), and metals that can be enriched in industrial wastes.

Chemical fingerprinting may require conducting special types of laboratory analyses with environmental samples. For example, PAH data available from environmental investigations are commonly limited to 16 compounds known as priority pollutant PAH analytes, designated by the U.S. Environmental Protection Agency (EPA). However, this regulatory-driven PAH list is not intended for detailed PAH source characterization. As such, the scientific community has expanded the EPA analytical list for fingerprinting purposes to include more than 30 PAH compounds. Similar discussion can be applied to PCBs, as regulatory focus is typically on Aroclor analysis, while a more complete PCB congener analysis is typically used in chemical fingerprinting. Laboratory methods to analyze crude oil and petroleum products, PCBs, and other chemicals have been developing since the 1980s, and laboratories continue to enhance their analytical capabilities. Today, laboratories can detect contamination at lower concentrations than ever before and use sophisticated analytical methods such as isotope analysis, two-dimensional gas chromatography (GC×GC), and other cutting-edge analyses to identify chemicals that were not of concern in the past, such as per- and poly-fluorinated alkyl compounds (PFAS).

# Using Environmental Forensics to Determine Liability for Environmental Contamination

After laboratory data are obtained, scientists can use a multitude of data analysis tools, such as:

- Age-dating sediment samples and associated contamination to calculate when contamination impacted the environment
- Isotope analysis of specific compounds (e.g., metals or chlorinated solvents) to link contamination to a specific feedstock or waste material
- Statistical tools such as polytopic vector analysis (PVA) or other mathematical models to numerically "unmix" comingled contaminant fingerprints in sediment and allocate percent contributions from different upload sources, even if the sources have long been removed.

## Chemical Fate and Transport Analysis and Other Forensic Tools

Whereas chemical fingerprinting is sometimes central to an environmental forensics study, scientists can use other types of chemical fate, transport, and source tracking/timing analysis methods. For example, depending on site details, analysis of groundwater and surface water flows, sediment transport, chemical spatial concentration patterns, and bathymetry data may be used to calculate contaminant source locations and timing of the release(s).

## How Exponent Can Help

Understanding the applicability and limitations of chemical forensics tools is necessary for successful interpretation of data obtained from contamination at a site. It is important to avoid the misapplication or misinterpretation of chemical fingerprinting data or other forensic tools, because this can result in incorrect conclusions about liability for contamination.

Our team at Exponent has published numerous peer-reviewed scientific articles and books on topics related to chemical fingerprinting, the fate and transport principles of chemicals in different environmental media, reconstruction of historical chemical releases, changes that occur to chemicals in the environment (e.g., weathering), and exposure assessments. We have assisted clients in toxic torts, property damage cases, allocation of contamination response costs, and National Resource Damage Assessments (NRDAs) nationwide, among many other legal and regulatory scenarios.

## Sources

Sample publications are listed below. For a complete list, visit Exponent's Environmental Forensics services page.


- Boehm, P.D., J. Pietari, L. Cook, and T. Saba. Improving rigor in polycyclic aromatic hydrocarbon source fingerprinting, Environmental Forensics, 2018; DOI:10.1080/15275922.2018.1474287.
- Saba, T., and S. Su. Tracking polychlorinated biphenyls (PCBs) congener patterns in Newark Bay surface sediment using principal component analysis (PCA) and positive matrix factorization (PMF). Journal of Hazardous Materials 2013; 260:634–643. http://dx.doi.org/10.1016/j.jhazmat.2013.05.046.
- Saba, T., and P.D. Boehm. Quantitative polychlorinated biphenyl (PCB) congener and homologue profile comparisons. Environmental Forensics 2011; 12(2):134–142.
- O'Reilly, K.T., S. Ahn, J. Pietari, P. Boehm. Use of receptor models to evaluate sources of PAHs in sediments. Polycyclic Aromatic Compounds. 2015; 35:41–56.
- Murphy, B.L., F.M. Mohsen. Reconstructed plume method for identifying sources of chlorinated solvents. Environmental Forensics. 2010; 11(1):60–71.



**Tarek Saba, Ph.D.**

**Environmental & Earth Sciences**

Principal Scientist & Office Director

Maynard

(978) 461-4605 | tsaba@exponent.com


**Exponent Office Locations**

Atlanta, Austin, Boston Area (Maynard, Natick), Chicago Area (Downtown Chicago, Warrenville), Denver, Detroit, Houston, Miami, New York, Philadelphia, Phoenix, Northern California Area (Menlo Park, Oakland, Sacramento), Seattle, Southern California Area (Los Angeles, Orange County, Pasadena), Washington DC Area (District of Columbia, Maryland, Virginia)

**International Offices:**

Basel, Switzerland; Derby, Harrogate and London, UK; Düsseldorf, Germany; Shanghai and Hong Kong, China

**www.exponent.com**