

February 2011



Spectrum Analytical, Inc.

Environmental Forensic Geochemistry Studies

Spectrum Analytical, Inc. provides services in support of environmental forensic studies associated with property transfer, insurance litigation from a release of contaminants, and cost/responsibility allocation at contaminated sites in terrestrial and marine environments. Through a variety of analytical tests and expertise in data interpretation/validation, Spectrum's experts can provide answers to critical environmental forensic questions such as when and how contamination occurred, who caused it, what is the extent and level of contamination, and what is the validity of the data obtained.



As necessary, Spectrum's experts will work with the client to review and validate existing site assessment and remediation data and devise a site-specific forensic plan that will answer the questions posed by the client. The plan may include collecting additional and defensible site assessment data and conducting a series of analytical tests in order to form a strong line of scientific evidence that can be used in a court of law.

Spectrum has conducted numerous petroleum forensic investigations for various environmental consulting firms. Spectrum is currently developing the capability for conducting Compound Specific Isotope Analysis (CSIA) to complete its forensic offerings.



SPECTRUM ANALYTICAL, INC.
Featuring
HANIBAL TECHNOLOGY

The Forensic group at Spectrum is led by Dr. Amine Dahmani and Dr. Hanibal Tayeh. Dr. Dahmani has worked in the oil industry for four years before joining the Civil and Environmental Engineering Department at the University of Connecticut (UConn) in 1990 as an Assistant Professor, to work on petroleum related environmental problems. He was the Director of the Site Assessment and Remediation laboratories at the Environmental Research Institute at UConn before joining Spectrum Analytical as the Section Team Leader of Research and Development in June 2005. He is currently Deputy Director of R&D at Spectrum Analytical, Inc. He has conducted numerous studies in site assessment, remediation, environmental forensics, and environmental monitoring. He was instrumental in the development of two important remediation technologies, namely air sparging and chemical oxidation. His knowledge of petroleum products and fate and transport of petroleum contaminants is critical in the conduct of forensic studies. Dr. Dahmani has also served as Adjunct Professor in the Civil and Environmental Engineering Department at UConn.

Dr. Tayeh is the President-CEO-Director of Spectrum Analytical, Inc. Dr. Tayeh is also an adjunct professor at the Environmental Science Program of the University of Massachusetts in Amherst. Dr. Tayeh has twenty-one (21) years of managerial, Quality Assurance/Quality Control (QA/QC) and Research and Development (R&D) experience. This includes the development and implementation of various environmental analytical methods to identify and quantify total petroleum hydrocarbons by gas chromatography (GC), polynuclear aromatic hydrocarbons by gas chromatography/mass spectrometry (GC/MS), polychlorinated biphenyls (PCBs) and chlorinated hydrocarbons pesticides by gas chromatography/Electron Capture Detector (GC/ECD) as well as volatile organic compounds via GC/MS. Dr. Tayeh performed all quality assurance/quality control (QA/QC) and method detection limit studies related to these methods and their implementation in the laboratory. Dr. Tayeh was also instrumental in the development of the Massachusetts Department of Environmental Protection (MADEP) methods for petroleum hydrocarbon determination, Extractable Petroleum Hydrocarbon (EPH) and Volatile Petroleum Hydrocarbon (VPH) with his direct involvement with the Mass DEP technical team in Lawrence and Boston, Massachusetts, to support the finalization of these particular methods. Dr. Tayeh's research and experience has led him to develop an innovative analytical method for the determination of petroleum hydrocarbons, total petroleum hydrocarbon technique (TPHT). He has presented this method to University of Massachusetts, Amherst and has conducted several technical seminars with environmental consultants pertaining to this technique. He has also utilized this method with various environmental consulting firms to provide support services associated with property transfer, insurance litigation from a release of contaminants, and cost/responsibility allocation at Superfund sites and other contaminated sites in terrestrial, marine or atmospheric environments.

Forensic Study Approach for Petroleum Products

Based on the forensic questions that are posed, the following approach is proposed:

1. Review of Relevant Site Assessment/Characterization Data

Existing site assessment/characterization data that can be used for the forensic investigation proposed is first identified. A thorough examination of the accuracy and reliability of the existing data is conducted. This includes sample collection techniques used, sample handling, analytical methodology and Quality Assurance/Quality Control methods used. Original copies of the existing data is requested from the client in order to conduct a proper evaluation. This includes sampling field notes, Chain of Custody (COC) forms, and analytical laboratory results with bench notes.

2. Usage of Validated Data

Data that is useable for the forensic study will be evaluated to determine if it is sufficient to answer the forensic questions posed. If that is the case, no further testing will be necessary.

3. Supplementary Sampling and Analysis Plan

If the existing data is not sufficient to address the forensic questions, additional sampling and analysis will be proposed. A plan will be developed by Spectrum and the client. In general, a preliminary GC/FID analysis is conducted on one or a combination of samples of free product (if available), groundwater and soil. This is necessary in order to identify the type of petroleum contamination present (gasoline, diesel, jet fuel, kerosene, etc.) and in some cases the approximate mixing ratios of the different products. The hydrocarbon (HC) patterns observed can also provide preliminary data information.

Based on the preliminary analysis, further testing may be required and one or a combination of the following analyses may be conducted:

- GC/MS VOC analysis for volatile compounds including oxygenates (MTBE, TAME, DIPE and ETBE) and alcohols (TBA and ethanol).
- GC/MS SVOC analysis for semi-volatile compounds
- GC/ECD or GC/MS analysis for additives (alkylated lead compounds, MMT).
- GC/MS PIANO VOC analysis (Paraffins, Isoparaffins, Aromatics, Naphthenes, and Olefins) and selected oxygen- and sulfur-containing analytes, and MMT.
- Total sulfur content analysis by ICP.
- Specific GC fingerprint using GC/MS (SIM).
- Biomarkers (for diesel and heavier fuels, lubricating oils and crude oil): acyclic isoprenoids, such as the C14 to C20 regular isoprenoids, sesquiterpenoids, diterpenoids, tricyclic and tetracyclic terpanes.
- Alkyl substituted PAHs, triterpanes and steranes by GC/MS (SIM) for MGP/coal tar sites and crude oil-related marine spills.
- Compound Specific Isotope Analysis (CSIA), under development.

4. Data Analysis

Spectrum uses the various analytical testing tools and site information to assess weathering of the fuels (volatilization, dissolution, biodegradation). Various weathering indices are used to evaluate the different types and degrees of weathering in fuels. In addition, the data collected can be used to compare various fuel samples from a site to assess the presence or absence of multiple sources of the fuels. In the case of heavier fuels, crude oil and MGP/coal tar contamination, samples are compared through fingerprinting, alkyl-PAH analysis and diagnostic ratio evaluation of biomarkers.

Age dating of the fuels can also be estimated. For gasoline, age dating can be estimated based on a combination of factors such as the rate of weathering, gasoline additives, temporal trends in refining and blending, and groundwater BTEX ratios, if applicable. For #2 fuel oil, isoprenoid analysis is conducted and correlations are used for age estimation.