



Karen Murray, Ph.D.

Senior Managing Scientist | Environmental and Earth Sciences
Natick
+1-508-903-4677 | kmurray@exponent.com

Professional Profile

Dr. Karen J. Murray is an environmental chemist and microbiologist who investigates the fate and transport of contaminants such as petroleum, mercury, and other metals in environmental systems. Her work involves a variety of environmental contexts, including litigation support, site assessment, and regulatory compliance.

Dr. Murray has advised clients on technical matters related to major oil spills and natural resource damage assessment (NRDA) cases. She specializes in the use of environmental forensics to determine the source of environmental contamination and the evaluation of interactions between microorganisms and chemicals that may alter the potential toxicity or mobility of contaminants. Dr. Murray is experienced in the application of oil spill fate and transport models and helps clients understand how models can be used defensibly to supplement available environmental data in complex cases.

Dr. Murray applies cutting-edge analytical techniques, such as non-traditional stable isotope analysis and molecular biological analyses to answer questions related to biodegradation, NRDA, and environmental forensics applications. Her background in analytical chemistry allows her to evaluate and interpret large environmental data sets for a variety of chemicals of interest to her clients. In particular, she has provided technical consulting on cases of mercury contamination, focusing on the complex chemical and biological reactions that control the methylation and, therefore, toxicity of this metal.

She has also worked extensively on petroleum hydrocarbon fingerprinting to identify the source and extent of contamination from oil spills, leaking tanks and other accidental releases. She has participated in the design and implementation of field and laboratory studies to determine the behavior of organic and inorganic chemicals in complex environmental media and provides support in related litigation matters.

Academic Credentials & Professional Honors

Ph.D., Oceanography (Geochemistry), University of California, San Diego, 2005

B.S., Environmental Engineering Science, Massachusetts Institute of Technology (MIT), 1999

Recipient of the Environmental Protection Agency STAR graduate fellowship

Prior Experience

Postdoctoral Researcher, Soil and Environmental Biogeochemistry Lab, Stanford University, 2005-2007

Professional Affiliations

American Chemical Society

American Society of Microbiology

Publications

Murray KJ, Boehm PD, Prince RC. 2019. The Importance of Understanding Transport and Degradation of Oil and Gasses from Deep-Sea Blowouts. In: Deep Oil Spills: Facts, Fate and Effects. Murawski S, Ainsworth C, Gilbert S, Hollander D, Paris C, Schlüter M, Wetzel D. (Eds.). Springer Nature.

Murray KJ, Boehm PD. 2017. Towards an Understanding of the Evolution (Fate and Transport) of the 2010 Deepwater Horizon Oil Spill. In: Proceedings of the 2017 International Oil Spill Conference, Vol 2017, No 1.

Morrison AM, Edwards M, Buonagurio J, Cook L, Murray K, Boehm P. 2017. Assessing the representativeness and sufficiency of water samples collected during an oil spill. In: Proceedings of the 2017 International Oil Spill Conference, Vol 2017, No 1.

Challenger G, Murray K. 2017. Comparability of SCAT Observations and Chemical Analytical Data in the Deepwater Horizon Oil Spill. In: Proceedings of the 2017 International Oil Spill Conference, Vol 2017, No 1.

Murray K, Brown J, Cook L, Boehm P. 2017. Fingerprinting of weathered oil residues in sediments from the Deepwater Horizon Oil Spill: The importance of multiple lines of investigation. In: Proceedings of the 2017 International Oil Spill Conference, Vol 2017, No 1.

Bigham G, Masue-Slowey Y, Murray K, Henry E. Critical Review - Biogeochemical controls on methylmercury in soils and sediments: Implications for site management. Integrated Environmental Assessment and Management. V 13, No. 2, pp 249–263, 2017.

Boehm PD, Murray KJ, Cook LL. 2016. Distribution and attenuation of polycyclic aromatic hydrocarbons in Gulf of Mexico seawater from the Deepwater Horizon oil accident. Environmental Science and Technology 2016. <http://dx.doi.org/10.1021/acs.est.5b03616>.

Boehm PD, Cook LL, Murray KJ. 2011. Aromatic hydrocarbon concentrations in seawater: Deepwater Horizon oil spill. In: International Oil Spill Conference Proceedings (IOSC) 2011; 1(371), American Petroleum Institute, March 2011.

Murray KJ, Webb SM, Bargar JR, Tebo BM. Indirect oxidation of Co(II) in the presence of the marine Mn(II)-oxidizing bacterium *Bacillus* sp. strain SG-1. Applied and Environmental Microbiology 2007; 73(21):6905–6909.

Murray KJ, Tebo BM. Cr(III) is indirectly oxidized by the Mn(II)-oxidizing bacterium *Bacillus* sp. strain SG-1. Environmental Science and Technology 2007; 41:528–533.

Glazer BT, Luther III GW, Konovalov SK, Friederich GE, Nuzzio DB, Trouwborst RE, Tebo BM, Clement B, Murray K, Romanov AS. Documenting the suboxic zone of the Black Sea via high-resolution real-time redox profiling. Deep-Sea Research 2006; 53:1740–1755.

Murray KJ, Mozafarzadeh ML, Tebo BM. Cr(III) oxidation and Cr toxicity in cultures of the manganese(II)-oxidizing *Pseudomonas putida* strain GB-1. Geomicrobiology Journal 2005; 22:151–159.

Murray KJ, Tebo BM. Active bacterial Mn(II)-oxidation accelerates Cr(III) oxidation compared to abiotic oxidation by Mn minerals. Geochimica et Cosmochimica Acta 2005; 69(10):A456–A456 Suppl. S.

Murray KJ, Tebo BM. Cr(III) is indirectly oxidized by the Mn(II)-oxidizing bacterium *Bacillus* sp. Strain SG-1. Abstracts of Papers of the American Chemical Society 2005; 228:U896–U896 089-Geoc Part 1.

Murray KJ, Mozafarzadeh ML, Tebo BM. Role of manganese(II)-oxidizing bacteria in chromium (III) oxidation. Abstracts of papers of the American Chemical Society 2004; 227:U1212-U1212 124-Geoc Part 1.

Tebo BM, Bargar JR, Clement BG, Dick GJ, Murray KL, Parker D, Verity R, Webb SM. Biogenic manganese oxides: Properties and mechanisms of formation. *Annual Review of Earth and Planetary Sciences* 2004; 32:287–328.

Konovalov SK, Murray JW, Luther GW, Buesseler KO, Friedrich G, Tebo BM, Samodurov AS, Gregoire M, Ivanov LI, Romanov AS, Clement B, Murray K. Oxygen fluxes, redox processes and the suboxic zone in the Black Sea. In: *Oceanography of the Eastern Mediterranean and Black Sea: Similarities and Differences of Two Interconnected Basins*. Yilmaz A (ed), Tübitak Publishers, pp. 566–577, Ankara, Turkey, 2003.

Konovalov SK, Luther GW, Friedrich GE, Nuzzio DB, Tebo BM, Murray JW, Oguz T, Glazer B, Trouwborst RE, Clement B, Murray KJ, Romanov AS. Lateral injection of oxygen with the Bosphorus plume — Fingers of oxidizing potential in the Black Sea. *Limnology and Oceanography* 2003; 48(6):2369–2376.

Jay JA, Murray KJ, Gilmour CC, Mason RP, Morel FMM, Roberts AL, Hemond HF. Mercury methylation by *Desulfovibrio desulfuricans* ND132 in the presence of polysulfides. *Applied and Environmental Microbiology* 2002; 68(11):5741–5745.

Presentations

Murray K, Gilman L, Beegle-Krause CJ. Untangling History, Filling Gaps, and Predicting the Future: The Role of Numerical Models in Oil Spills and Other Environmental Contamination Cases, MCLE Credit Webinar, June 21, 2018.

Murray KJ, Cook LL, Brown JS, Boehm PD. Using Sediment Hydrocarbon Fingerprinting to Understand Oil Transport, Distribution and Degradation after the Deepwater Horizon Oil Spill. Ninth International Battelle Conference on Remediation and Management of Contaminated Sediments. New Orleans, LA. January 9–12, 2017.

Murray KJ, Cook LL, Brown JS, Boehm PD. Four Years of Chemical Measurements from the Deepwater Horizon Oil Spill Define the Deep Sea Sediment Footprint and Subsequent Recovery. 016 Gulf of Mexico Oil Spill and Ecosystem Science Conference, New Orleans, LA. February 1–4, 2016.

Masue-Slowey Y, Murray KJ, Shields WJ. Stable Isotopes and the Courtroom - Use and Misuse of Stable Isotopes in Criminal and Environmental Forensic Cases, MCLE Credit Webinar, May 28, 2014.

Bragg JR, Pope GA, Gordon KD, Murray K, Atlas RM. Effects of partitioning and bioavailability on biodegradation of PAH in weathered Exxon Valdez oil remaining in Prince William Sound. 2nd International Symposium on Bioremediation and Sustainable Environmental Technologies, Jacksonville, FL, June 10–13, 2013.

Atlas R, Cook L, Murray K, Cerreto K, Faith S, Boehm P. Biodegradation of hydrocarbons within the water column and marsh sediments following the Deepwater Horizon Accident. American Geophysical Union, Fall Meeting, San Francisco, CA, 2012.

Boehm PD, Cook LL, Murray KJ, Brown J, Royer L. Distribution and fate of PAH and chemical dispersant concentrations in the water column following the Deepwater Horizon accident. 243rd ACS National

Meeting & Exposition, San Diego, CA, March 25–29, 2012.

Atlas R, Murray K, Cook L, Boehm P. Fate of Deepwater Horizon oil: Biodegradation of aromatic and saturated hydrocarbons associated with oil in the water column. 243rd ACS National Meeting & Exposition, San Diego, CA, March 25–29, 2012.

Boehm PD, Murray KJ, Shea D. Laboratory measurements of dissolved and droplet PAHs in MC252 oil-water-dispersant mixtures inform partitioning after Deepwater Horizon oil spill. Proceedings, SETAC North America 32nd Annual Meeting, Boston, MA, November 13–17, 2011; Society of Environmental Toxicology and Chemistry, Boston, MA, 2011; p 211.

Murray KJ, Tebo BM. Active bacterial Mn(II)-oxidation accelerates Cr(III) oxidation compared to abiotic oxidation by Mn minerals. The 15th Annual Goldschmidt Conference, Moscow, ID, May 20–25, 2005.

Murray KJ, Tebo BM. Cr(III) oxidation is accelerated by the Mn(II)-oxidizing bacterium *Bacillus* sp. strain SG-1. University of California Research and Teaching Program Annual Symposium. Sacramento, CA, April 2005.

Murray KJ, Tebo BM. Cr(III) is indirectly oxidized by the Mn(II)-oxidizing bacterium *Bacillus* sp. strain SG-1. 229th American Chemical Society National Meeting & Exposition, San Diego, CA, March 13–17, 2005.

Murray KJ, Tebo BM. Chromium oxidation by Mn oxidizing bacteria from the Black Sea. ASLO/TOS 2004 Ocean Research Conference, Honolulu, HI, February 15–20, 2004.

Murray KJ, Mozafarzadeh ML, Tebo BM. Role of manganese(II)-oxidizing bacteria in chromium(III) oxidation. The 227th ACS National Meeting, Anaheim, CA, March 28–April 1, 2004.

Murray KJ, Arias YM, Tebo BM. Comparison of sediment redox profiles under two conditions of Cr(VI) pollution in a marine mesocosm study. University of California Research and Teaching Program Annual Symposium, Tahoe, CA, April 2001.

Project Experience

Petroleum

Served as the technical lead for BP for a multi-institutional team to analyze the chemical data associated with the Deepwater Horizon NRDA. Developed and implemented a protocol for fingerprinting sediment samples from the Deepwater Horizon to determine the presence of MC252 oil for use in the injury assessment.

For a major oil company, in conjunction with a team of industry and academic scientists, designed and ran a series of laboratory experiments to examine the partitioning of chemical components of weathered oil from sediments to water under various conditions. Duties included the management of the sampling, review of the analytical results, and analysis and reporting of the chemical data.

In support of a litigation matter, reviewed chemistry data and a newly developed oil spill fate and transport model to evaluate reported oil source fingerprinting and resource exposure estimates.

Managed a project to evaluate the concentrations of chemical components in produced waters from fracking operations over a regional area. Effort included sampling, lab coordination, and data validation for a suite of standard organic and inorganic chemicals, including radioisotopes. Additionally, appropriate analytical methods for a list of proprietary chemicals in use in fracking operations were researched and analytical procedures and approaches for future investigations were recommended. Analyzed chemical and physical data as well as historical documents associated with a gasoline plume in groundwater under

an urban area with multiple potential sources. Used various environmental forensic techniques to determine the approximate age of the release and the likely source. Assisted with the preparation of an expert report and worked closely with the client during third-party depositions.

For a major oil company, conducted a technology review of available and emerging instrumentation for quantifying hydrocarbons in water in real time. Provided recommendations for suitable technologies to assist with regulatory compliance.

Served as chief scientist on an oceanographic survey to collect sediment for chemical and biological analysis to support an NRDA case.

Conducted a site investigation and analyzed samples of groundwater for an environmental forensics case involving a potential leaking underground storage tank for home heating oil in support of litigation.

Reviewed historical and site investigation documents for a natural resources damages case involving historical petroleum refinery operations.

Metals

For a major oil company, worked with a team of chemists, hydrologists, ecologists and toxicologists to develop an ecological and human health risk assessment of mercury emissions from an on-shore gas processing facility. Specifically, was responsible for understanding the chemical and biological fate of deposited mercury.

Evaluated a patented treatment method for the stabilization of cadmium and lead in fly ash from a waste-to-energy (WTE) facility and the potential for remobilization under landfill conditions for a client operating a landfill. The goal of this work was to understand the cause of regulatory exceedances reported by the WTE operator. Project included an evaluation of the chemistry of the treatment method, an investigation of the specific laboratory methods used to confirm stabilization, and a field investigation of the landfilled waste to evaluate landfill conditions.

Served as a consulting expert for a client on technical issues related to mercury and lead contamination allegedly associated with the operations of a nearby smelter. This project included the review and interpretation of data generated in association with both NRDA and remedial investigation/feasibility study efforts.

For an oil company, served as principal investigator for the analysis of potential water column trace metal contamination associated with exploratory drilling for oil in the Arctic. Designed a shipboard lab and worked with a team of scientists from multiple organizations to collect and process trace-metal clean samples at sea to comply with regulatory discharge permits.

Evaluated sources of mercury to river sediments using mercury stable isotope techniques in support of an expert witness report.

Provided technical review of lead stable isotope chemical data associated with air samples collected adjacent to an active mine and advised client on further research needs to support risk assessment work.

Assisted in the preparation of a report regarding the impact of a proposed urban chilled-water system that would discharge to a lake with historical mercury contamination. Specifically responsible for the development of a chapter to address the potential chemical changes resulting from the discharge of a variable flow of potable water to one of the tributaries that discharges into the lake and any possible effects of the discharge on remediation efforts.

Monitored the published literature and summarized new mercury stable isotope studies that were provided as periodic reports to a client considering this technique to study mercury-contaminated sediments.

Used traditional stable isotopes (carbon, nitrogen) and mercury measurements to analyze the food web associated with a lake with historical mercury contamination. In addition to performing the data analysis, worked with the laboratory to acquire the data and validated the results received.

Coordinated laboratory analysis of sediment and water samples associated with a site potentially impacted by metals and other contaminants from bauxite ore processing and analyzed the resulting data using various environmental forensic techniques. Assisted with expert report and rebuttal preparation.

Reviewed available documents associated with the remedial activities at various historical chlor-alkali plants with mercury contamination and assisted with the development of exhibits for a litigation matter.

Provided support to an expert witness in a litigation matter involving the chemistry of arsenic and other metals used in historical paint manufacturing.

Microbiology

Evaluated available data and provided technical comments on the potential for microbial contamination of local water resources associated with a proposed dairy farm.

Served on an external expert panel for the NASA Life Detection workshop (2018).

Provided technical chemistry and microbiology support in a consumer product investigation of corrosive gypsum wallboard with a team that included human health and corrosion scientists. Provided a comprehensive review of potential chemical reactions of wallboard and worked with the team to design experiments to test potential causes of the corrosion.

Evaluated proprietary hydraulic oils used in shipboard operations for potential compliance with new regulatory requirements for biodegradability, based on reported chemical properties and compositions. Prepared a memo summarizing these results for the client to aid in decision-making.

Assisted in the production of a technical manual for biotreatment of petroleum based on multiple previously used protocols and other research. Worked closely with the client to develop the document.

Reviewed and summarized available published research on the potential biological transformations of various chlorinated solvents to support an expert witness in a litigation matter.

Other

For a trade organization, researched available literature and wrote a white paper on the analytical methods used to measure chemicals transferred to food associated with the use of mineral oil in food packaging.

Provided technical support in an environmental forensics case of chlorinated solvent groundwater contamination in an urban area. Specific duties included review and summary of historical documents and site investigation results.