



Environmental Forensics

Proceedings of the 2014 INEF Conference

Edited by Gwen O'Sullivan and David Megson



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Foreword

Stephen Mudge

The world of Environmental Forensics is full of interesting people, real-world cases and techniques and many of these came together at Cambridge in August 2014 to showcase the state of the art. INEF was formed to provide a platform for practitioners to get together, physically and virtually, to advance our specialties. We had a meeting in St. John's College, Cambridge in 2011 and this was very successful both scientifically and socially hence our desire to go back to this location. I am pleased to say that both the location and weather delivered for us again and we had a great meeting. We had 85 participants from more than 15 countries with 45 presentations and workshop sessions; we are grateful to all those who made the journey to Cambridge to share their experiences and knowledge.



INEF is a charitable organisation under the Royal Society of Chemistry umbrella and we always endeavour to keep the costs as low as possible to cover the expense to running the event. Additionally, we try and support younger members of our community with reduced rates, where possible. We are exceptionally grateful to the companies that have sponsored us and enabled us to provide these lower rates and the activities at the meetings. In 2014, we wish to acknowledge; Restek, Markes international, Shimadzu, Thermo, JSB and RSC for their new and continued support for us – please continue to view their websites and use their services when appropriate.

As practitioners of Environmental Forensics, we have an impressive armoury of tools available to us to do everything from identification of the sources, apportion responsibility, age date releases, determine “damage” and answer any manner of related questions. I find when talking to people new to our work, they are always amazed at what is now possible and your work, presentations and publications are a great way of getting this over to the outside community. It was not too long ago that we were unable to identify what was under the UCM hump in a GC trace – not only can we identify what is there now, we can use this to tell us a whole lot more about the processes in the environment. These and other great innovations are what make EF such an exciting area to work.

I would like to that all those who organised and facilitated the meeting and invite you to join us for our next meeting in Toronto, 2015.

Author Biographies

Gwen O'Sullivan Dr Gwen O'Sullivan is an Assistant Professor of Environmental Science at Mount Royal University. Dr O'Sullivan earned a B.Sc. in Environmental Science from the University of Limerick and a PhD in Environmental Chemistry from Queen's University of Belfast. Over the course of her career, in industry, consultancy and academia, Dr O'Sullivan has developed technical expertise in the areas of environmental chemistry, environmental forensics, air quality and contaminated land and groundwater. She has worked on numerous research and industrial projects including the development of technologies and remedial actions plans for the treatment of petroleum hydrocarbons, chlorinated solvents, and saline impacted sites. She has also designed and managed environmental forensic investigations involving compounds of concerns including drilling fluids, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, polychlorinated dibenzo-*p*-dioxins and dibenzofurans, methane and nitrates. She has also authored numerous scientific articles, edited books series and successfully competed for research grant both nationally and internationally.



David Megson Dr David Megson is a post-doctoral research fellow at Ryerson University who is conducting research at the Ontario Ministry of Environment and Climate Change. Dr Megson is currently investigating sources of legacy and emerging persistent organic pollutants and monitoring their fate and transport in the terrestrial and marine environment. He is undertaking the extraction of soils, biosolids, and marine mammal tissues and performing analysis using advanced mass spectrometry techniques including GCxGC-HRToFMS and FTICR. Dr Megson obtained a PhD at Plymouth University (UK), using multidimensional chromatography to create high resolution PCB signatures for use as an ecological monitoring tool and to identify and age date human exposure to PCBs. David also holds a BSc in Environmental Forensics and an MSc in Environmental Analysis and Assessment. He has over four years experience working in the UK as an environmental consultant, specialising in human health risk assessment and contaminant fate and transport. He has undertaken contaminated land assessments, remediation projects and forensic investigations involving source identification of ground gas, PAHs, PCBs and PCDD/Fs. He has published several scientific papers and co-authored book chapters in the field of environmental forensics focusing on POPs in the environment. Dr Megson is a member of the Royal Society of Chemistry, the Society of Brownfield Risk Assessment and is an associate fellow of the higher education academy.





Anne Brosnan Anne Brosnan is the Deputy Director (Chief Prosecutor) Legal Services, Environment Agency, England. She is a qualified solicitor with Higher Rights of Audience in Criminal Proceedings and a Masters degree in Environmental Quality Management. In 2005 she spent a year in Sydney Australia on a working exchange with the then Department of Environment and Conservation. Anne established the Agency's Serious Casework Group in 2007 and was closely involved with the introduction the English environmental civil sanctions regime in 2010. Anne is Co President of the European Network of Prosecutors for the Environment (ENPE) founded in September 2012.

Cristina Barbieri Cristina Barazzetti Barbieri is a Criminalist at the Criminalistics Department/IGP, official forensic agency of Rio Grande do Sul State Government, since 1997. She started to work with environmental crimes investigation from the beginning of her career as a forensic expert. Cristina is a biologist and completed her undergraduate studies at PUC-RS, Porto Alegre, RS, Brazil. She has a Specialization Course in Environmental Quality Management by the same University and a MSc degree in Ecology at UFRGS. She is now finishing her PhD in Nuclear Technology-Materials at IPEN/USP, where she develops a work related to environmental crimes forensics tracking sources of contaminants in sediments, using metals, isotopes and organics.



Hsin-Lan Hsu Dr Hsin-Lan Hsu is a senior researcher in the Department of Environmental Forensics at Industrial Technology and Research Institute, a leading research organization in Taiwan devoted to develop technologies for industries and the government. She is currently developing the compound-specific isotope analysis for carbon, hydrogen and chloride isotopes of organic compounds in groundwater, air and sediments and working closely with the Taiwan EPA and local consulting companies to identify the sources of chlorinated

organic compounds in the groundwater. Dr Hsu obtained a PhD in the Environmental and Water Resources Engineering program at the University of Michigan, Ann Arbor, MI, where she studied the impact of surface-active impurities of organic liquid waste on the liquid waste transport in the groundwater. She also holds a BSc in Physics and MSc in Environmental Engineering at the National Taiwan University. Dr Hsu is specialized in chlorinated DNAPL

contaminations and had spent more than seven years of career life undertaking site investigation, remediation, and forensic projects. She is a member of Taiwan Association of Soil and Groundwater Environmental Protection and Chinese Environmental Analytical Society.

Jean Christophe Balouet Dr Jean-Christophe Balouet is a former research scientist at the Paris Museum of Natural History and Smithsonian Institution. Over the past 26 years, he has served dozens of governmental, intergovernmental and non-governmental organizations and over 120 forensic cases worldwide. His expertise deals with air, soil and groundwater pollution. His interest in age-dating pollution has led him to develop dendrochemical methods over the past 15 years. He is the author of over 100 peer-reviewed scientific articles. He serves environmental forensic organisations, such as ISEF as associate editor, or Compagnie Nationale des Experts Judiciaires en Environnement as Secretary General.



Robert Morrison Dr Robert D. Morrison has a B.S. in Geology, a MS in Environmental Studies, a MS in Environmental Engineering, and a PhD in Soil Physics from the University of Wisconsin at Madison. Dr Morrison has worked for 45 years as an environmental consultant on projects related to soil and groundwater contamination, including site investigations and remediation. Dr Morrison currently specializes in the forensic review and interpretation of scientific data to identify the source and age of a contaminant release. Dr Morrison is the co-founder of the International Society of Environmental Forensics (ISEF) and the International Network of Environmental Forensics (INEF) and has served as Chief Editor of the *Journal of Environmental Forensics* and on the editorial board of *Ground Water* and *Ground Water Monitoring Review & Remediation*, among others. Dr Morrison wrote the first book on environmental forensics in 1999 and is credited with coining the term *environmental forensics* in the peer reviewed literature. Dr Morrison is the author or co-author of 15 books and numerous peer-reviewed articles, the majority of which address environmental forensic subjects

Daniel Bouchard Dr Daniel Bouchard obtained a MSc in Soil Science (Laval University, Canada) and a PhD in Hydrogeology (University of Neuchâtel, Switzerland). Daniel is currently a researcher at the Centre for Hydrogeology and Geothermic (University of Neuchâtel, Switzerland). He has over 10 years of experience specializing in compound-specific isotope analysis (CSIA). Over the last decade, he has contributed to expand CSIA application to gas-phase contaminant characterization present in the soil gas, to performance assessment of groundwater remediation treatments, and also developed new analytical methods combined with field sampling methods to collect gas-phase contaminants in view to apply CSIA in forensics studies.



John Bruce John Bruce is currently working as a Knowledge Transfer Partnership Associate for the University of Portsmouth and DustScan Ltd, investigating methods of dust dispersion modelling for implementation into DustScan's business. His role includes research into empirical modelling of dust based on observed measurements and utilising air quality modelling software for use in dust predictions. He obtained a BSc in Environmental Forensics from the University of Portsmouth in 2012 and now has over two years' experience in environmental consultancy. Mr Bruce is an Associate Member of the

Institute of Air Quality Management and the Institute of Environmental Sciences. He is currently studying towards a PhD at the University of Portsmouth with his research focusing on expanding and improving on the empirical aspects of his dust modelling for the KTP project.

Rory Doherty Rory is an environmental engineer / geoscientist whose interdisciplinary research and teaching is based on the role, fate, monitoring and management of contaminants. His research encompasses geogenic and anthropogenic sources and sinks of contamination as well as the emerging discipline of biogeophysics where geophysical techniques can be used to monitor subsurface microbial activity in large scale bioelectrical systems. Rory has extensive remediation experience with recent academic work in the investigation, monitoring and management of brownfield sites. At Queen's University Belfast he has worked on projects that have developed biological Permeable Reactive Barriers and ex situ chemox remediation approaches.





Michael Wade Dr Michael J. Wade is Principal Scientist of Wade Research, Inc.™, a small business that provides geochemical consulting services to a variety of government agencies, industrial clients, and law firms. Dr Wade is an organic geochemist with over 36 years post-doctoral experience with an overall total of 43 years of strong technical and project management experience in a variety of research programs with special emphasis on study of organic contamination in the environment. He regularly provides expert forensic services both through deposition process as well as testimony in various U.S. Federal and State Courts in the areas of environmental contamination, including assessment of sources of contamination,

identification of petroleum product types, quantification of weathering effects on petroleum products, and age-dating of petroleum product releases. Since 1992, working through Wade Research, Inc., Dr Wade has engaged in the conduct of numerous projects dealing with the various aspects of environmental assessment, including measuring degradation of petroleum hydrocarbons and development of quantitative hydrocarbon fingerprinting techniques that identify sources of subsurface petroleum contamination. Recently, Dr Wade has devoted an increasing amount of time and effort to increasing the quantitative understanding of petroleum product weathering reactions in the environment. As part of his assignment mix, he has completed numerous assignment that have refined quantitative field and laboratory investigation approaches designed to establish time frames for the release of gasoline, kerosene, diesel fuel and heavier fuel oils in subsurface petroleum contamination cases. Annually, through Wade Research, Inc., Dr Wade conducts 20 to 30 such programs for clients throughout North America. In addition to his regular assignment mix, Dr Wade teaches forensic geochemical continuing education courses for a variety of state and professional society venues throughout the United States. Such courses provide today's environmental professionals with a broad background in organic chemistry that is then focussed down to specific tools that investigators can use to develop information on anthropogenic contaminants that lead to allocation discussions and/or legal responsibility resolution.

Andrea D'Anna Andrea D'Anna has 13 years of experience in Site Remediation and Engineering design; he holds a Masters degree in Environmental Science and has a Chemistry Expert certificate. Andrea joined AECOM in 2002 and joined the Process Engineering Group in 2006, and in 2009 began working on larger plants using innovative remediation technologies. During his career, Andrea has on worked on numerous remediation projects. His work has included preparation of risk analyses, coordination of design tasks, installation and O&M of multiple remediation systems such as SVE, AS, P&T, DPE, and TPE. Andrea has performed



LNAPL studies (environmental forensics – origin, timing, etc), prepared SCM for remediation technologies, sized remediation plants (biological, chemical-physic system, Activated Carbon), performed plant revamping and optimization, and prepared technical specifications. From two years Andrea worked on an innovative remediation systems including Oxygen Micro-bubbles injection, ERD system and In situ Thermal treatment). Principal Andrea's skills are: Theoretical knowledge of the matter, continuously updated (training), innovation technologies, wide range of remediation technologies; great experience in environmental sector, close relationship and trust with Clients/Supplier, negotiation skills with the Control Agencies, recognition by stakeholders (Control Agencies, local communities, universities, research institutions, associations, etc..) and lot of imagination (Think out of the Box). Andrea is a dynamic and collaborative person with a natural predisposition to give a hand to the next and team working and he is enthusiastic about innovative and sustainable Technologies.



Funmilayo Doherty Dr (Mrs) Doherty V. Funmilayo is an Environmental Toxicologist and a senior lecturer in the Environmental Biology unit, Yaba College of Technology. She attended Ahmadu Bello University, Zaria Nigeria, for her Bachelor's degree in Zoology and graduated with a second class upper. She obtained an MSc and PhD in Environmental Toxicology and Pollution Management from the University of Lagos, Nigeria. Her area of research interests include heavy metals monitoring and biological effects, impact of petroleum products spillage on aquatic and terrestrial ecosystems, biological effects of Hydrocarbons (BTEx) and identification of biomarkers of exposure to pollutants. Dr (Mrs) Doherty is a member of several professional bodies. She is a recipient of many awards, Scholarships and research grants, these include Federal Government Scholarship for Post graduate students in 2003, World bank Unilag Step-B Innovators of Tomorrow research grant in 2011, just to mention a few. She has over 30 publications in reputable national and international Journals. She has a passion for youths acquiring skills to develop themselves. Presently, Dr Doherty is the President, Society for Environmental Toxicology and Pollution Mitigation (SETPOM) and the Coordinator, Yaba College of Technology UNESCO-UNEVOC Centre for Research and Sustainable Development.

M. K. Ladipo Dr M. K. Ladipo is an analytical chemist and a chief lecturer in the Department of Polymer and Textile Technology, Yaba College of Technology with over 30 years experience. She attended Ahmadu Bello University, Zaria Nigeria, for her Bachelor's degree in Chemistry. She obtained an MSc in Polymer Science and Technology and PhD in analytical chemistry from the same University. Dr Ladipo is a member of several professional bodies including the Society for Environmental Toxicology and Pollution Mitigation (SETPOM), Polymer Institute of Nigeria



and Textile Society of Nigeria. She has several publications in reputable national and international Journals and has authored two books. She is a recipient of many awards; these include women in merit Gold award and Business Reports International Merit Award for Excellence in service to Humanity to mention a few. Her research interests include environmental monitoring of aquatic and terrestrial and effect of textile effluents on organisms and the environment.



Stephanie Turnbull Stephanie Marie Turnbull is a postgraduate researcher at the University of Glasgow who has recently started her PhD in the school of engineering. Stephanie's research focuses on the investigation of position specific isotope analysis which looks at the intramolecular structure of a molecule to determine their fate and transit during biodegradation. The aim is to further develop the methodology for the on-line system of analysis using a GC-c-IRMS.

Stephanie obtained a first class honours BSc in Forensic Science from the University of Wolverhampton (UK) in 2014. Stephanie concentrated her interests specifically into environmental forensics as a result of her sponsored attendance at an INEF conference in 2011. INEF 2011 allowed Stephanie to effectively network in order to secure numerous international/national internships with large multinational companies like AkzoNobel. As a result of this industrial experience Stephanie wrote her undergraduate dissertation on an environmental investigation project. This project was further selected to be presented at the University of Coventry and Cambridge University as part of INEF 2014. Stephanie is a member of the Royal Society of Chemistry and the British Mass Spectrometry Society.

Leo M. Rebele Mr. Rebele is a vice president and senior environmental scientist with the Irvine office of Tetra Tech, Inc. With over 18 years of experience in the environmental industry, he possesses a broad background in environmental science. He has worked in collaboration with numerous municipal and private clients to apply cutting edge technical, programmatic and funding approaches to environmental issues on redevelopment projects. Mr. Rebele advocates for the use of environmental forensics as a practical means to solve issues as part of property investigations and transactions rather than only using environmental forensics to support litigation projects. His experience includes the application of forensic techniques in establishing cleanup cost liability for commingled groundwater plumes of gasoline and chlorinated volatile organic compounds. He has also worked with waterfront property owners to establish potential sources of polynuclear aromatic hydrocarbons in soil and sediments. Mr. Rebele holds a Master of Science degree in Marine Resource Management from Oregon State University and undergraduate degree from the University of British Columbia in Biological Oceanography with an emphasis on nearshore pollution ecology.



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