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BOOK REVIEW

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Review of: *Introduction to Environmental Forensics*

REFERENCE: Murphy BL, Marison RD. Introduction to environmental forensics. Academic Press, San Diego, CA, 2002, 560 pp.

Since the passage of the Comprehensive Environmental Response, Compensation and Liability Act or CERCLA, commonly referred to as Superfund, the interest in and demand for forensic analyses of environmental problems has grown dramatically. The 1980 law established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. The act was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986 to increase the involvement of state governments, and many states have environmental regulations mirroring the federal Superfund rules. In addition to assigning responsibility for Superfund sites, there is a demand for forensic scientists to assist in the identification of entities responsible for marine spills, and for the assessment of real estate prior to sale.

The growing interest of the forensic science community in this emerging area can be seen in the number of papers on the subject presented to the Engineering Section of the American Academy of Forensic Sciences. There were five papers on environmental forensic science in 2000, and seventeen in 2003. *Introduction to Environmental Forensics*, while written as an introductory text, covers this wide-ranging field in a logical, easy to understand yet highly comprehensive series of articles provided by the editors and fifteen distinguished contributors. The editors have done a remarkable job in keeping the individual chapters consistent and in harmony with each other. The number and scope of investigational methodologies required for even a moderately complicated site assessment is staggering, yet this text seems to get its arms around the field in a way that makes it useful for forensic scientists and for the legislators, regulators and litigators who require their services.

In the introductory chapter, Editor Brian Murphy concisely sets out the four general contexts that trigger liability investigations, and the forensic issues that need to be addressed in each of these four contexts: cost allocation at Superfund sites; site investigations for property transfer; insurance litigation; and toxic tort litigation. The succeeding chapters then describe which tools need to be in the toolbox of the environmental forensic investigator, beginning with a chapter describing methods of site history research. This chapter outlines the simple hypothetical situation of a single party site, and also covers the incredibly complex situation of a landfill to which wastes generated off-site have been transported and inextricably commingled. The next tool is visual examination, which may involve photogrammetry, photo interpretation, digital imaging, aerial photography and mapping. The book comes complete with a set of 3-D glasses for viewing the color plates. This is followed by a discussion of sampling techniques and analytical methods. This chapter focuses sharply on potential sources of error and on the limitations of some of the standard EPA techniques used in environmental monitoring. There is an excellent discussion of the application of stable isotopes and radioisotopes in environmental forensics, techniques which help to overcome many of the difficulties introduced by evaporation, water washing, migration through adsorptive media and biodegradation.

The chapter on chemical fingerprinting of hydrocarbons contains several fascinating and well documented discussions of the three mechanisms (genetic, anthropogenic, and environmental) by which both crude and refined petroleum products acquire their unique fingerprints. The *n*-alkanes in petroleum derive from the decarboxylation of *n*-alkyl fatty acids in plant waxes. The relative abundance of odd and even numbered *n*-alkanes allows inferences to be drawn as to whether the plants that gave rise to them were terrestrial or marine. The acyclic isoprenoids such as pristane and phytane derive from the phytol side chain in the chlorophyll molecule. The discussion of the diagenetic processes that result in the transformation of biochemicals into biomarkers such as steranes and terpanes is particularly interesting. There is also a richly detailed discussion of the history of the processes used in the petroleum industry, including changes in cracking processes, additives such as alkyl leads and oxygenates, and reformulated gasolines. The molecular effects of these anthropogenic processes change the final signature in ways both obvious and subtle, and can assist in the dating of releases. This chapter should be required reading for all organic chemists, and particularly for fire debris analysts.

There is an extensive discussion of chlorinated solvents, as well as discussion of particulate analysis, and the changes that result from interaction of released particles with environmental substrates. After these chapters on data collection, the text moves into a detailed discussion of subsurface models, air dispersion models, and the statistical methods used in interpreting all of this data.

The statistics chapter is presented in a straightforward manner, but the limitations of applying the simpler statistical methods to environmental data are brought out in the final chapter, which discusses

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principal components analysis and receptor models. The discussion of the study of outliers, also referred to as "a surprise in a data set," and how each of these should be investigated and resolved is particularly instructive.

In fact, the entire text is very instructive in that it discusses not only the science, but also the forensics that follow the issuance of the report. With *Daubert* in mind, the authors highlight the limitations and areas susceptible to challenge in each of the techniques discussed. Inference of identity of source, a major function of forensic science, is also the major thrust of this text. The book does a very credible job at explaining the techniques, the limitations and the complexities involved in this emerging discipline.