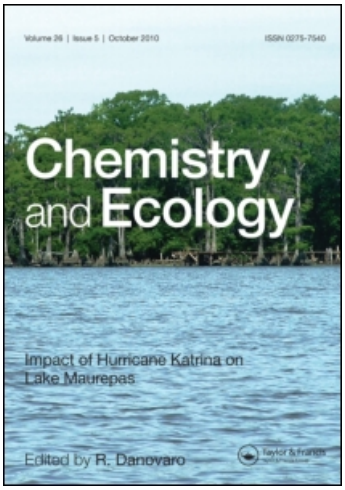

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BOOK REVIEWS

D. I. Wilson and A. N. Clarke (1994) Hazardous Waste Site Soil Remediation. 567 pp. Marcel Dekker Inc., New York (ISBN 0-8247-8980-6), Price £108.85.

Although the spectre of contaminated land registers has (temporarily?) receded in the UK, the potential costs of cleaning up soil and groundwaters contaminated with hazardous chemicals are still very high. The aim of this book (one of the excellent Environmental Science and Pollution Control series from Marcel Dekker) is to review the latest innovative techniques for remediation and clean-up. It claims to be aimed at a wide market of 'nonspecialist', but especially environmental regulators, managers and engineers. It tries to cover theoretical aspects and practical applications to promote meaningful site specific evaluation and cost-effective selection of techniques. Does it succeed in these aims?

The book comprises ten chapters, written by experts. As always, this tends to produce variations in presentation and depth. The editors and authors are all American, so it is not surprising that there is a strong bias toward US EPA and CERCLA/Superfund legislative and regulatory pressures—and towards North American examples.

The book broadly divides into two chapters on introductory groundwater hydrology, five on technologies involving removal/treatment, two on physicochemical transformations-immobilisation and one on bioremediation. The first chapter introduces fundamental theoretical aspects of groundwater hydrology and mass transport in relation to contaminant transport and subsurface migration and fates. Some of the figures are not very well printed and lack clarity and the mathematical treatments are often more appropriate to readers with a good prior knowledge of chemical engineering or hydrogeology. This is even more true of the following chapter when the authors, Mutch and Scott, introduce the further complexities of groundwater flow when matrix-diffusion is limiting and migration is affected by rock fracturing and fissuring. Both chapters make a good job of clarifying the problems of predicting contaminant movements and of removal from aquifers, and the value of arresting contaminant plume migration (e.g. by hydrofracturing).

The groundwater clean-up theme is continued in Chapter 7 by Haeppel and Hinchee with reference to biotreatment, i.e. enhancement of biodegradation by bacteria and fungi. As an introduction to basic microbiology and metabolic pathways of degradation, this chapter is excellent. It clarifies the needs for site-specific survey of problems and some of the means of encouraging microbial growth and biodegradation (e.g. via enhancement of oxygen and nutrient supply). Microbially-induced volatilisation and biobleaching are also covered. The authors complain that strict US regulations tend to inhibit development of innovative biotreatments. Despite this, it is a shame the authors did not discuss some of the pump-and-treat, land-farming and other techniques that have been used successfully in Europe.

The remaining chapters on extractive and immobilisation techniques give more practical examples and descriptions of commercially available systems. Extraction of VOCs (volatile organic compounds) and DNAPLs (dense nonaqueous phase liquids) feature in three chapters. These cover soil-vapour extraction, thermally-enhanced (including steam and radio-frequency) extraction and compressed air sparging technologies. Useful information is given on research and development in *in-situ* as well as *ex-situ* treatments (and stripping of vented vapours and gases). Subsequent chapters deal with thermal desorption of volatiles by indirect heating of solids or sludges, another with recent developments in *in-situ* washing and *ex-situ* washing with surfactants to extract heavy metals from soil. The coverage of principles and factors affecting applicability and cost-effectiveness in these chapters is very good—though again, a chemical engineer will be happier than most readers with some of the chemical and mathematical treatments provided.

The last pieces of the jigsaw fall into place in a chapter on chemical stabilisation and solidification techniques, including vitrification. Chemical conversions and detoxification are well discussed. Although immobilisation and encapsulation generally involve basic and well-tested inorganic-setting and/or curing agents or Portland cement technologies, problems can arise from inclusions of debris (e.g. metal drums and scrap metal). These are pointed out, as are possible problems of long-term stability and potential leaching. Applications of such techniques to metals and non-volatile organics are made clear, and useful examples of practical and commercial systems given. The use of such techniques in relation to radioactive wastes is not discussed, however.

Overall, this book can be recommended as a good introduction to the main proven and developing technologies in soil and groundwater remediation. Unfortunately the title does not make it clearer that, quite rightly, the text devotes much space to groundwater contamination. Many chapters are more suited to chemists, engineers and hydrogeologists (preferably with a good grounding in maths!) than environmental managers and regulators. The book has a heavy bias towards US problems and regulations and some chapters are lacking in practical and commercial examples. Despite these drawbacks, it gives a good account of 'state-of-the-art' remediation technologies and likely future developments.

Brian Knights

Symposium Mediterranean Seas 2000, Norberto F.-R. Della Croce (Editor), 489 pp. Istituto Scienze Ambientali Marine 1993.

As the title suggests, this book is a compilation of the proceedings of a Symposium. The Symposium was held 23–27 September 1991 at the Institute of Marine Environmental Sciences at Santa Margherita Ligure. The Institute is a part of the University of Genoa and the Symposium was the final one of a series of events organised to mark the opening of the Institute's premises which started in October 1990.

Publication of the Symposium proceedings clearly seemed a good idea in advance of, and at the time of, the proceedings and it probably still is in actual fact. The aim was to publish the proceedings rapidly after the event and indeed thanks are recorded for the

assistance the Editor received which allowed publication in such a short time. As two years is hardly short, I suspect these thanks were either written before the event or with the benefit of hindsight as to how difficult the task actually proved. Clearly the Editor had the usual problem with the authors of Symposium papers over the quality of their manuscripts and figures. The proceedings were recorded but this seems to have made his difficulties more acute as he clearly felt duty bound to make the best job he could of reporting the discussion in full. I am not at all sure this was in fact a good idea; omission would not have been a great loss as many of the interventions are fairly light weight. In fact I found myself reading them purely for light relief or so as to spot such speaker asides as "is it working" referring to the microphone or the Editor's frustrated remarks such as "rest of question inaudible". Often it has to be admitted even the edited text is unintelligible.

The papers appear in the order in which they were presented, in session groups of three papers in each of six sessions. There is no obvious theme to any session and perhaps the idea was simply to try and ensure that each session appealed to as many of the attendees as possible. Despite this they are an interesting mix and there are some genuinely well worthwhile reads. Some new information is presented—for example reports on small anoxic basins which had not previously been suspected to exist in the Mediterranean Sea and a report on, what has until recently been the very under-studied, benthos of that area.

The reader or proposed purchaser should not be misled by the title into believing that all the papers relate to *the* Mediterranean Sea. They do not, rather they refer to mediterranean seas in general. There are therefore papers on the Caribbean, the Black Sea, the North Sea and even Limfjord as well as various aspects of the Mediterranean and its basins. The paper on Limfjord offers a series of absolutely classic examples of major changes occurring in the natural environment completely independent of man's activities. Nevertheless there are other cases where man's apparently puny efforts do seem to have had major and quite unpredicted effects e.g. the effects of the Aswan Dam on coastal erosion in Egypt as a consequence of a drastic reduction in sediment feed by the Nile to the sea.

In short, there is at least one paper and probably several to interest just about everyone in this four hundred plus page volume. The Symposium organisers managed to attract some of the big names in marine science and the publication merits a place on the library shelf of major marine institutes.

The Symposium volume may be obtained directly from Istituto Scienze Ambientali Marine, C.P.79, Corso Raimusso 14, 16038 S. Margherita Ligure (GE), Italy, enclosing $10 (US) for postage and packing.

J. E. Portmann
1 February 1994

Organic substances in soil and water: Natural constituents and their influences on contaminant behaviour. Edited by A. J. Beck, K. C. Jones, M. H. B. Hayes and U. Mingelgrin. Published by The Royal Society of Chemistry (Special Publication No. 135), 1993, ISBN 0-85186-635-2, 200pp. Price £55.00

The subject of this book is extremely topical and relevant to a wide range of current concerns in environmental science and pollution control. The book contains a series of the keynote papers which were presented at the International Conference on Organic Substances in Soil and Water held at Lancaster University, UK during September 1992. The selection of authors is certainly international, all recognised experts in their respective research fields. The book is sub-divided into 2 main sections. The first, comprising of 3 papers, attempts an overview of the importance, distribution, isolation and composition of organic matter in soils and waters. The second longer section with 7 papers discusses various aspects of the interaction between contaminants and naturally occurring organic substances.

In general, I feel the balance of subjects covered is good and the papers follow a natural sequence. My main criticism would be the limited attempt by some authors to put the relevance of their reviews into an international or even national context. This I found disappointing. The lack of interaction and cross referencing between individual papers is helped greatly by a final overview section which does a good job in pulling things together and provides suggestions for future needs.

The general structure of the book and text is good, and it has a comprehensive index. There are a few areas that lack uniformity in style between papers, particularly regarding sections on conclusions and future emphasis. There are a number of very good texts on this general subject area currently available. However, I think the attempt of this book to include the consequences for contaminant behaviour and environmental implications means that for anyone with an interest in this aspect it is worth having a look at.

A. C. Edwards

Chemical Fate and Transport in the Environment, H. F. Hemond and E. J. Fechner, publ. Academic Press Inc., London, 1994. ISBN 0-12-340270-0, 338 pp., $49.95

This graduate students' text is based on a one-semester course covering the basic principles of chemical behaviour in the environment. It is not intended for those specializing in environmental engineering but for others pursuing wider studies with a need for an understanding of concepts involved and some familiarity with practical problems. It has developed from class notes prepared for the MIT course and, through several revisions, has profited by feedback from both students and their tutors. Although aimed at the north American market, it is equally applicable to European courses.

As such it is exemplary, covering the fundamental principles of mass transport, chemical partitioning, chemical transformations in surface waters, ground waters, sub-surface and atmospheric environments. Many students of environmental science have come via largely non-scientific backgrounds, and even those with a background of biological science may have little experience or predilection for understanding physical or chemical phenomena, or are able to quantify physical and chemical processes. This book sets out, most clearly, intuitively based mathematical models for the chemical transport and transformations within environmental media that determine the fate of pollutants.

The first chapter covers basic concepts - mass balance, advection and dispersion, basic chemistry and chemical equilibrium, partition coefficients. The following chapters cover, in turn, surface waters, the subsurface environment (including ground water), and the atmosphere. Each begins with an overview of the medium characteristics, and follows with a careful development of the physical and chemical, then biological processes involved in pollutant behaviour. In each chapter there are worked examples in the text based on practical problems, and further exercises are also provided.

The book is well produced and illustrated. References for further reading are given for each chapter, mainly north American but not difficult to access. There is a small Appendix of dimensions and units used in environmental studies; this is possibly unnecessary, but some students may not know where else to find reference to these. There is an adequate and accurate index.

I would recommend this book, not only to the graduate students to whom it is addressed, but also to their tutors who may themselves be unfamiliar with the quantitative handling of data from field experiments or from theoretical examples. Many of the examples could be used for illustrating and quantifying concepts that should be included in lectures on environmental science. It could also be useful at the undergraduate level with some judicious selection of material.

The authors' preface provides a foretaste of its contents – "We hope you find the book helpful, even enjoyable, and come away sharing... our enthusiasm.. and our desire to treat the environment from a basis of appreciation and understanding." I think it will be found to meet that aim.

G. Howells
2 June 1994

Biodegradation and Bioremediation, Alexander, A. (1994) 302 pp. Academic Press Inc., San Diego, ISBN 0-12-049860-X, £38.00.

Biodegradation of compounds has interested scientists for more than 40 years. Interest was initially stimulated by concerns about persistence of pesticides in soils but more recently, the focus has widened, particularly towards the possible development of 'bioremediation' technologies to enhance microbial biodegradation of organic pollutants. The costs of cleaning up soil and groundwaters contaminated with hazardous chemicals are very high and such enhancement technologies might offer cost-effective alternatives. The stated aim of this book is to present the basic principles of biodegradation and to show how these principles relate to bioremediation. The Preface admits that the field is too large and diverse and its knowledge base expanding too rapidly for this book to cover all aspects. It is claimed that it should be useful to microbiologists, chemists, toxicologists and environmental scientists and engineers. Does it succeed in its aims to present a good grounding in general principles for such a readership?

The book comprises sixteen chapters, including an introduction. Only one is devoted totally to bioremediation technologies *per se*, the rest deal with factors affecting the growth and physiology of microorganisms and chemical and environmental factors

that affect rates and efficiency of biodegradation. This reviewer would personally liked to have seen more time devoted to the technologies used and the book could have fed through to this as its concluding (and prominent) chapter. Instead, it is placed as the penultimate chapter, to be followed by one on recalcitrance (i.e. the causes of resistance to biodegradation). Furthermore, many of the aspects of recalcitrance were touched on, even if only indirectly, in earlier chapters and could perhaps have been better integrated in the relevant sections of text. But these are possibly minor criticisms, did it overall give a good coverage of the fundamentals of biodegradation? The conclusion must be yes, although the text was heavy-going at times and would have gained from being broken up rather more into coherent subsections. Also, a summary of the key points of each chapter would help the reader who is not already an expert in this field.

The introduction is followed by a very short chapter dealing with biodegradation which involves utilisation of carbon and other elements in growth and energy production. The author assumes the reader has at least a basic working knowledge of microbiology. Although not essential, non-specialists might be advised to do some background reading to enhance their understanding of this and subsequent chapters. Acclimation is discussed next (i.e. the 'lag phase', before any significant biodegradation occurs). This is important because on one hand, the delay may increase relative exposure time and hazards, whereas, on the other hand, acclimation may occur simultaneously to other analagous substrates, enhancing the spectrum of biodegradative abilities. Explanations for the lag phase are given later (why not nearer the beginning?), with particular emphasis on enzyme induction and the appearance of new genotypes. Subsequent chapters describe the processes of detoxication of compounds (by enzymatic hydroxylation, dehalogenation, etc.) and the converse, activation, where biodegradation can result in production of metabolites more harmful than the original compound. The latter discussion sounds a warning to those who believe bioremediation always results in the production of harmless end-products!

Kinetics of biodegradation are discussed at some length in Chapter 6—heavy going for non-microbiologists but a good summary nonetheless—to be followed by more on thresholds. This, although short, is important because of the need to optimise bioremediation of contaminants present at very low levels in the environment. Factors affecting rates of biodegradation (sorption, low aqueous solubility, sequestering and complexing) are covered in Chapters 8 to 10. These all primarily relate to 'bioavailability' of compounds, i.e. whether they are in forms in the environment which make them easily accessible to enzymatic breakdown. Other factors affecting rates of breakdown are discussed in subsequent chapters, i.e. metabolic and environmental ones, such as low temperature or lack of nutrients, and those relating to resistance to enzymatic action due to chemical structures and bondings. The latter points tended to be repeated in the final chapter, after discussion of inoculation and bioremediation technologies.

This review has perhaps been somewhat cirtical of the structure of this book but overall, it can be recommended as a good introduction to the principles of biodegradation and bioremediation. As a reference book, it is a mine of information, although admittedly it cannot go into real depth in 286 pages of text. For example, the potential uses of genetically engineered microorganisms can only be spared four pages of text. It has a competent index and it includes good bibliographies at the end of each chapter – although I wish publishers would give full titles of papers rather than just the journal

sources. It will not be an 'easy-read' for non-microbiologists but it is worth the effort if you need to gain an overview of current status of our knowledge and likely future developments in the fields of biodegradation and biotreatment.

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