THE ROYAL SOCIETY OF CHEMISTRY

ENVIRONMENTAL CHEMISTRY GROUP

Bulletin

January 2004

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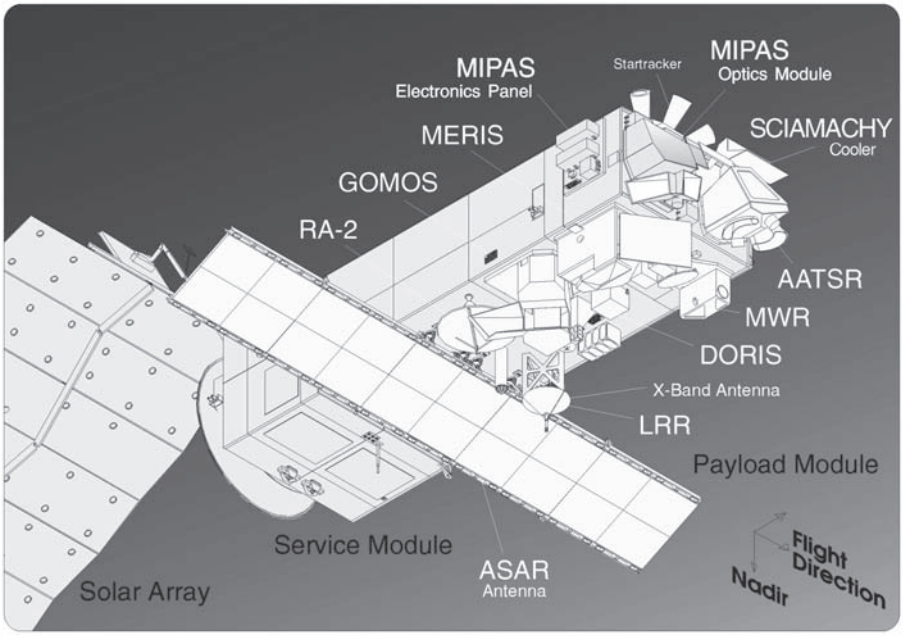
ECG Bulletin – January 2004

The current ECG Bulletin may be seen on the internet at http://www.rsc.org/lap/rsccom/dab/scaf003.htm



Envisat is an advanced Earth observation satellite with a unique combination of sensors to vastly improve the range and accuracy of scientific measurements of the atmosphere, oceans, land surface and ice. Its total range of capabilities far exceeds those of any previous or planned Earth observation satellite. It was launched in spring 2002 by an Ariane-5 launcher.

ECG Distinguished Guest Lecture & Symposium, March 3rd 2004
"Environmental Chemistry from Space"

RSC ENVIRONMENTAL CHEMISTRY GROUP OFFICERS

(from March 2003)

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Environment, Sustainability and Energy Forum

Recent developments within the RSC's Environment, Sustainability and Energy Forum (ESEF) include the appointment of Dr Elliot Finer as Chair of the Forum and Dr Andrea Jackson as Vice-Chair.

Elliot Finer has recently held key appointments as Director General of the Chemicals Industries Association (1996 – 2002), Head of Chemicals and Biotechnology Division, DTI (1992 – 1995), and Director General of the Energy Efficiency Office in the Department of Energy (1988 – 1990). **Andrea Jackson**, who is also Chair of the **Environmental Chemistry Group**, is a Lecturer at the University of Leeds in the School of the Environment and her main research interest is the chemistry of the atmosphere. **Dr Eimear Cotter**, from the RSC, will support and manage the initiatives and activities of the Forum. Eimear's research background is also in atmospheric chemistry – before joining the RSC she spent several years in academic research and has also worked as an environmental consultant for Arthur D. Little Ltd.

With these recent appointments, activities within the Forum are beginning to gather pace. The executive committee is currently being formed and once this has been completed, the first executive committee meeting will take place in 2004 where ESEF strategy and key initiatives will be discussed and developed further.

For more information about the Environment, Sustainability and Energy Forum, please go to www.rsc.org/science/esef.htm or contact Eimear Cotter at cottere@rsc.org or call 020 7440 3333.

Forthcoming symposium

Royal Society of Chemistry Environmental Chemistry Group

Thirty-first Annual General Meeting and 2004 Distinguished Guest Lecture & Symposium: *Environmental Chemistry from Space*

To be held in the Meeting Room of the Linnean Society of London, Burlington House, Piccadilly, London on Wednesday March 3rd 2004

PROGRAMME

13.30 Chairman's Introduction: Dr Andrea Jackson (Chair, RSC Environmental Chemistry Group)

13.35 Dr Paul Monks, University of Leicester
Probing the troposphere from space

14.20 Professor Jim Aiken, Plymouth Marine Laboratory
Remote-sensing of air-sea fluxes of CO_2: constraining the global CO_2 budgets

15.05 Tea and **RSC Environmental Chemistry Group Annual General Meeting**

15.30 Introduction to the 2004 RSC ECG Distinguished Guest Lecture

15.35 **2004 RSC Environmental Chemistry Group Distinguished Guest Lecture:** Professor John Burrows, University of Bremen
Viewing the earth's environment from space: the challenges, the progress and the future

16.35 Open Forum

17.00 Close

The nearest underground stations to the Linnean Society are Green Park and Piccadilly Circus.

"The atmosphere and earth form a system, which determine the nature and behaviour of the environment, experienced by mankind and the biosphere. Prior to the industrial revolution, the global impact of anthropogenic activity on the environment was negligibly small. However, the growth in population and associated living standards in the past two centuries has been such that pollution is now a global issue; well known examples are the tropospheric release of chlorofluorocarbon compounds and the consequent depletion of stratospheric ozone; the reduction in air quality and the increase in tropospheric ozone; and the release of greenhouse gases. The origin and consequences of both natural and anthropogenically-induced changes in atmospheric composition have become a matter of public concern and scientific debate.

In the past decade it has been demonstrated that tropospheric measurements of important trace gases and aerosol can be made from space. The capability of passive remote sensing devices attached to geostationary platforms for measuring atmospheric trace constituents will be described."
Professor John Burrows, University of Bremen

"The Centre for Air-Sea Interactions and fluxes research programme will be described. The purpose of CASIX is to exploit new-generation Earth Observation (EO) data to advance the science of air-sea interactions and reduce the errors in the prediction of climate change. The primary goal is to quantify accurately the global air-sea fluxes of CO_2 using state-of-the-art, error-budgeted models. New sensors in new satellites (Envisat, Aqua) will give high-precision, high-resolution data of atmosphere, ocean boundary layer properties and ocean biogeochemical variables daily, globally, and long term. Only by using and assimilating EO data in models can CASIX achieve its goals. CASIX will merge the Met Office ocean

modelling team and major UK academic research groups, with Space Agency support, to accelerate the development of methods of forecasting Earth system processes."
Prof. Jim Aiken, Plymouth Marine Laboratory

"One of the major challenges facing atmospheric science is to assess, understand and quantify the impact of natural and anthropogenic pollution on the quality of life on Earth on a local, regional and global scale. It has become apparent that pollution originating from local/regional events can have serious effects on the composition of the lower atmosphere on a global scale. Remote sensing from space has the potential to be a cornerstone of future observational strategies in this area. This lecture will review the current capability, future ideas and underlying science of probing the troposphere from space."
Dr Paul Monks, University of Leicester

Royal Society of Chemistry Environmental Chemistry Group 31st Annual General Meeting

Meeting Room, the Linnean Society of London, Wednesday 3rd March 2004, 15.05 pm

AGENDA

1. Apologies for absence
2. Minutes of the 30th AGM held on 5th March 2003 at the Linnean Society of London
3. Report on Group Activities
4. Election of officers and members of the Committee
5. Any other business

The composition of the present Committee is given below, with an indication of members who will be retiring under the rules of the Group.

Chairman
Dr Andrea Jackson (University of Leeds)
Vice-Chairman
Dr Brendan Keely (University of York)
Hon. Treasurer
Dr Brendan Keely (University of York)
Hon. Secretary
Dr Leo Salter (Cornwall College)

Committee Members:
Dr Kim Cooke (Sira Ltd)
Dr Chris Harrington (University of Leicester)
Prof. Steve Hill (University of Plymouth)
Dr Michael Leggett (British Standards Institution)
Dr Rupert Purchase (Consultant)

Representatives on the ECG Committee:
Dr John Hoskins (OETG)
Dr Steven Lipworth (EHSC) (Royal Society of Chemistry)

Dr Andrea Jackson retires as Chair and moves to Vice-Chair and Honorary Treasurer.
Dr Brendan Keely retires as Vice-Chairman and moves to Chair.
Dr Brendan Keely retires as Honorary Treasurer.
Dr Leo Salter remains as Honorary Secretary.

ROYAL SOCIETY OF CHEMISTRY ENVIRONMENTAL CHEMISTRY GROUP

Thirty-first Annual General Meeting and Distinguished Guest Lecture & Symposium: "**Environmental Chemistry from Space**", March 3rd 2004

There are no registration formalities associated with this meeting and guests are welcome, but in order to assist the organisers it would be appreciated if those intending to be present would notify **Dr Michael Leggett** by means of the slip below or by e-mail. There will be a charge of £5 for non-members of the Environmental Chemistry Group, which should be returned with the slip (cheques made payable to *RSC Environmental Chemistry Group*).

Please tick the item(s) below as appropriate.

I would like to attend:

The AGM ❑

The Symposium ❑

I enclose a cheque for the £5 registration fee (non-members of the ECG only) ❑

Name: .....

Address: .....

.....

.....

Please send to: Dr Michael Leggett (Mike.leggett@bsi-global.com), British Standards Institution, 389 Chiswick High Road, London W4 4AL

Institute of Environmental Management & Assessment (IEMA)

IEMA Student Essay Award Winner 2003

'The price of everything and the value of nothing': Economics and monetary valuation of the environment.

The debate concerning our ability to place a cash value on the environment represents a sharp point of difference between two views of the world. From one perspective, the planet and its workings are seen as a complex, barely understood tangle of cause and effect; from the other, it is, at least in theory, knowable, measurable and ultimately, predictable. At heart, it is a political debate and the position one finally adopts, for or against, is likely to be conditioned by core beliefs. In his 2003 award winning IEMA student essay, **Colin Bush** explores the issues.

Those who feel most strongly that the environment can be treated as an economic good, much like any other, are to be found amongst the ranks of economists. In this view, economic theory demonstrates that, given a viable pricing mechanism for environmental goods, the 'invisible hand' of Adam Smith will provide, and markets can be made to work for the environment. This essay will argue that such a view is at best misleading; at worst, a dangerous fantasy, unlikely to lead to the outcomes its proponents confidently expect.

Let us first examine the case for putting a price on nature. According to Bowers in *Sustainability and environmental economics* (1997), "Neo-classical environmental economists argue that environmental problems arise from market failure and define the optimum state of the environment as that which would hold were the sources of market failure corrected."

Markets can fail for two principal reasons, held to be of great importance in explaining why environmental degradation occurs.

First is the problem of 'public goods', free for use by anyone, owned by no one. Air, for instance, is a public good. No market exists for it, it cannot be traded and nobody profits from its consumption. Equally nobody has an incentive to maintain air quality because everyone benefits from improvements paid for by a few. So, the argument runs, the optimum level of air quality will never be reached because a rational economic agent – and all people and firms are held to behave 'rationally' – will not pay the cost of the improvement.

Second are externalities, which arise when the market has no price for the impact of consumption by one agent upon the utility of another. For example, a factory owner might dispose of wastes in a river that is also used for drinking water. The utility of the thirsty is affected by the pollution but there is no cost to the factory owner and therefore no incentive to alleviate the pollution.

The solution, according to economists, is to assign property rights and to price the environment. Property rights must be well defined, secure and enforceable, freely transferable and exclusive if the market is to function correctly. Without these features, a rational person or firm would not purchase a good because its full benefits cannot be enjoyed. Who owns the property rights is unimportant. Either way, an optimum level of pollution control will be found at the equilibrium point where the utility enjoyed by both sides is at its greatest when measured against the cost to both sides.

Pearce and Turner in their book, *Economics of natural resources and the environment* (1990), point out that if the Coase theorem,* as this is known, is correct "we have no need for government regulation of externality, for the market will take care of itself". However, there are a number of dubious assumptions that must be made for the theorem to hold, perhaps the most important being that the market must be perfectly competitive. Pearce and Turner add: "perfect competition is a convenient fiction for constructing economic models, but it is remote from the real world."

Even the most enthusiastic environmental economists admit that the Coase theorem is seriously flawed, however this has not prevented the construction of other models based on the behaviour of rational economic agents. Hanley, Shogren, and White in their *Introduction to environmental economics* (2001), calculate the optimal area of rainforest left standing when the present value of the marginal benefits of clearing equals the present value of the marginal benefits of preservation. In their book, *Environmental economics: an elementary introduction* (1994), Turner, Pearce and Bateman demonstrate the optimal level of wastage, the equilibrium between the marginal benefits of reducing waste and the marginal costs of preventing waste reaching the environment.

Before such models can be applied it is essential to be able to quantify, for instance, the marginal benefits of preserving an area of rainforest. Since the benefits of clearing trees are measured in currency then, *ipso facto*, so must be the benefits of preservation. But there is no market selling the benefits of preserving a rainforest and they are not priced: until they are, the model is useless. Once prices are assigned, some economists argue, the model can function as a guide to policy because the loss of rainforest is an example of the first type of market failure: rainforest is a public good.

Various techniques have been proposed to value the environment; none of them are completely satisfactory. Jacobs in *The green economy* (1991) points out that describing the full benefits of an environmental good may be impossible if we have incomplete knowledge of its function in the ecosystem. In economic terms it is foolish to try to quantify such

benefits, since one of the assumptions required for the market to function is that economic agents have complete knowledge of what is being traded. Nevertheless, economists have tried to assign prices to environmental assets using two general methods:

One method infers a value from goods associated with the environmental asset: economic agents are said to reveal their preference for the environmental good in relation to the amount they actually pay for the associated good. An analysis based on the market price of houses near the environmental asset, or the amount of money spent travelling to the asset, have been suggested as examples of this method of valuation.

The other method relies on asking people what they would be willing to pay to keep an environmental asset, or alternatively what they would be willing to accept in compensation for its loss. A number of issues bedevil this approach, for instance there is the danger of inbuilt bias in the process itself producing erroneous results, and issues concerning the veracity of the answers given by respondents.

Economists are well aware of these difficulties but some feel that the exercise should still be undertaken. According to Turner, Pearce and Bateman, in *Environmental economics: an elementary introduction* (1994), "Economic (monetary) valuation of non-market environmental assets may be more or less imperfect given the particular asset together with its environmental and valuation contexts; but, invariably, some valuation…is better than none, because none can mean some implicit valuation shrouded from public scrutiny."

Others are unconvinced. Bowers *in Sustainability and environmental economics* (1997) makes the point that, when used in a straightforward cost/benefit context, the concept of compensation for environmental degradation is meaningless because no such compensation is ever paid. He argues that prices cannot be assigned to the environment although the economic models themselves remain useful, "It is not the primary task of environmental economics to place values on environmental assets and…with many environmental assets no meaningful monetary valuations can be derived…however it is not necessary to value such assets in order to devise and appraise environmental policies."

Schumacher in *Small is beautiful: a study of economics as if people mattered* (1974) goes further calling valuation, "…A procedure by which the higher is reduced to the level of the lower and the priceless is given a price…All it can do is lead to self deception and the deception of others; for to undertake to measure the immeasurable is absurd and constitutes but an elaborate method of moving from preconceived notions to forgone conclusions."

And this is indeed the fear: by reducing environmental assets to economic goods, the very situation that environmental economics seeks to avoid will be brought about more swiftly. Environmental degradation will be facilitated.

One feels that modern economists are akin to Marxists in their belief in the universal applicability of their creed. Insofar as they apply economic theory to the relationship between people and the environment, they go further than Marxists ever dared. The problem, according to Redclift in *Sustainable environmental economics and management: principles and practice* (1993), is that economists "have chosen to understand what we do not know in terms of what we do".

But is it even the case that 'economics' is understood? Some believe that the hubris of neo-classical economists is gravely misplaced: "The ability of orthodox economics to understand the workings of the economy at the overall level…is manifestly weak (some would say it was entirely non-existent). This is not to say that the subject is a completely empty box. At the detailed level – the micro level – economics might be able to offer certain insights…It is when economics strays from the particular into the general that its weaknesses are exposed more ruthlessly – *The death of economics* (1994).

According to this view, that of former econometrician Paul Ormerod, the claims of economics to be able to make predictions about the behaviour of the economy are entirely unjustified by the results. To take just one example, the United Kingdom Treasury annual forecast of Gross Domestic Product for the coming year has been in error, on average, by 1.5%. During the same period the average growth in GDP was only 2%, almost the same size as the error. *(Butterfly economics,* 1998*)*. Treasury economists are not unusually incompetent: the issue is that the neo-classical economic models in use everywhere are fundamentally flawed.

The belief in the efficiency of the market place has its mathematical proof in the work done by Walras and Pareto in the early Twentieth century. This shows that in a free market economy all markets will 'clear' and resources will be allocated in the most efficient way possible. Unfortunately the mathematics only work under certain assumptions and, when these are considered, it becomes obvious that the whole construction resembles the proverbial house built on sand.

The mathematics require a so-called "continuum of traders", a literally infinite body of economic agents, all of whom must have perfect knowledge of the goods being traded in order to price them correctly. These are hardly realistic assumptions, but without them the mathematics proving the existence of a general equilibrium, where all markets 'clear', simply do not obtain.

The infinity of omniscient men and women are all assumed to have the same preferences and act rationally to satisfy them, with diminishing marginal returns in the utility gained for each unit of consumption. This supposed rationality of individuals is challenged by Loomes, in *Probability versus money: a test of some fundamental assumptions about decision making, Economic Journal, No 447,* (1998), who maintains that people are not "characterised by some set of fully formed and highly articulated preferences which they can and will apply consistently to any and every form of decision problem"... His research may suggest "the need for a…radical reformation of certain basic precepts of decision theory and welfare economics".

The continuing appeal of neo-classical economics rests mainly on the undeniable

success of Western market economies over the last couple of centuries, but this intellectual hegemony is called into question by Ormerod, who insists: "it cannot be emphasised too strongly that, in practice, the competitive model is far removed from being a reasonable representation of Western economies…". The theoretical model of the general equilibrium does not, therefore, explain or even approximate the actual economy. It follows that there is no justification for the belief that free markets will of themselves limit environmental degradation to the optimal level.

Our understanding of the workings of the economy is lacking. Much empirical evidence exists to suggest that its operation is similar to the non-linear, chaotic fashion of many complex systems in the natural world. Such evidence compellingly explains the sudden, apparently random shifts in behaviour in financial markets or national economies.

Perhaps this is not surprising: it accords with a common sense view of the economy, of human society, as a part of the wider environment. Jacobs in *The green economy* (1991) has shown that the economy relies completely on the environment in order to function and that, without the services provided by the environment, there would be no economy. To treat the natural world as a mere segment of the economy, as some economists would, is to put the cart before the horse on a colossal scale.

Ormerod captures well the fundamental reason why the grandiose claims made by some neo-classical economists contribute little to the debate on environmental protection: "Economists see the world as a machine…whose workings can be understood by putting together carefully and meticulously its component parts…A lever pulled in a certain part of the machine with a certain strength will have regular and predictable outcomes elsewhere in the machine…Environmentalists, by contrast, see the world as a living organism. Prodding the system in a certain way in a certain place may sometimes cause the beast to hop in one direction, sometimes in another, and sometimes it will not move at all…behaviour is altogether too complex to be captured by a mechanistic approach." *(The death of economics*, 1994*)*

This latter view is as true of people and the economy as it is of the world as a whole. There is no reason to believe that markets can be made to work for the environment because orthodox economic theory is a chimera. Markets will only find the optimum state of the environment by accident. We must not allow policy to be driven by the dictates of a flawed theory or great harm may accrue to the environment.

COLIN BUSH,
Oxford Brookes University,
MSc Environmental Assessment and Management

REFERENCES

This essay with a full list of the references can be obtained from editor@iema.net The ECG thanks the IEMA for permission to reproduce this essay.

***The "Coase Theorem"**
Nobel laureate Ronald Coase is Professor Emeritus of Law and Economics at the University of Chicago. He is interested in the "efficiency" of tort rules, i.e. in the rules' tendency to bring about an "efficient" outcome, defined as one in which the net sum of social wealth (a proxy for social happiness, but more easily measured) is maximised. Recognising that safety has costs, Coase and his followers think of an efficient rule as one that minimises the sum of accident costs and prevention costs, because such a rule will, given other assumptions, subtract the least from social wealth. Note that "efficiency" in this sense (called "Pareto" efficiency after the economist Vilfredo Pareto) does not require that costs be allocated justly between people. Justice is a separate ideal, from the economists' perspective. Some economists (not all) have argued that justice is a confused, contestable idea, and that society would be better off if tort rules were fashioned solely to advance efficiency. (Editor's note *via* Google).

What the ECG can do for you!

Included in this issue of the Environmental Chemistry Group (ECG) Bulletin is a questionnaire, "*What the ECG can do for you!*" The ECG committee is in a process of reviewing its activities so that it can continue to provide high quality information, events and meetings which encompass the diverse range of interests of RSC members who belong to the Environmental Chemistry Group.

Whatever your scientific background and interests, you will have recently ticked your RSC 2004 subscription form to indicate an interest in the chemistry of the environment. We would very much like to know whether we currently fulfil your aspirations and interests, and also what specific new or different areas of environmental chemistry appeal to you.

The ECG is one of the largest subject groups within the RSC. With such a broad based membership and a rapidly changing environmental agenda at national and international level, this is an exciting time to help influence the direction and activities of the ECG. With this in mind, your contribution and feedback *via* the enclosed questionnaire will be an invaluable resource.

Dr CHRIS HARRINGTON,
University of Leicester,
Cancer Prevention and Biomarkers Group, Biocentre, University Road, Leicester

RSC Environmental Chemistry Group questionnaire

The Royal Society of Chemistry's Environmental Chemistry Group (ECG) wishes to expand the range of its activities. This questionnaire will help the ECG committee understand the requirements, needs and aspirations of the broader chemistry and science communities. This is an opportunity for you to shape the activities of the Environmental Chemistry Group. PLEASE take the time to complete this form and then return it to: **Dr CHRIS HARRINGTON**, University of Leicester, Cancer Prevention and Biomarkers Group, Biocentre, University Road, Leicester.

Job Title:

.....

Employer's main activity:

❑ Academic
❑ Industrial
❑ Public Sector
❑ Regulatory
❑ Other, please specify:

.....

Age group:

❑ 16-20 ❑ 21-30 ❑ 31-40
❑ 41-50 ❑ 51-60 ❑ 61-65
❑ 65+

Where do you live:

❑ Scotland ❑ Northern England
❑ Midlands ❑ Wales
❑ SW England ❑ SE England
❑ London

Your main areas of interest include:

❑ Analysis
❑ Research
❑ Education
❑ Health and safety
❑ Toxicology
❑ Regulatory compliance
❑ Environmental health
❑ Other, please specify:

.....

Previous attendance at ECG organised events:

❑ Often
❑ Seldom
❑ Never

Reasons for not attending ECG organised meetings:

❑ Not applicable to my interests
❑ Did not know about it
❑ Too expensive
❑ Too far to travel
❑ Too busy
❑ Other, please specify

.....

How do you find out about ECG meetings:

❑ RSC Journal
❑ Non-RSC Journal
❑ Chemistry World *(Chemistry in Britain)*
❑ ECG Bulletin
❑ Mailshot
❑ Colleague
❑ Other, please specify:

.....

Style of meetings you would like:

❑ More concerned with technology
❑ More concerned with regulatory affairs
❑ Joint meetings with other societies
❑ Joint meetings with other RSC subject groups
❑ Other please specify:

.....

If you would like to comment further about the ECG and it's activities, please do so on the reverse side of this questionnaire.

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE.

Application of ion chromatography in environmental analysis

It is probably true to say that ion chromatography has a rather low profile when compared to its more "glamorous" high performance liquid separation relatives such as LC-MS.

For example, how many local Chromatography Society meetings have been devoted to ion chromatography developments in the last 10 years? Not many I'll wager. Nevertheless, ion chromatography plays a very important part in some key areas of environmental analysis, mainly concerning natural and wastewaters. There have also been a number of important recent developments in separation and detection extending the range of analytes and sample types available to the technique.

The term "ion chromatography" strictly includes a number of high performance ion separation techniques, including ion exchange, ion exclusion, and ion pairing. But ion exchange is by far the most common system employed.

Looked at historically, ion exchange has had rather a chequered career in terms of popularity and importance. It is probably stretching credence a little when we are told by a number of reviewers that ion exchange was first mentioned in the Old Testament as a way of cleaning up the waters of Mâr'-ăh, which were bitter, by using a tree, "which when . . . cast into the waters, the waters were made sweet". (Exodus, 15:25). Assuming that the toxicity is due to metals, the explanation is that oxidised lignin, presumably in the bark, contains a high concentration of carboxyl groups which when ionised in water will act as ion exchange sites for metal absorption, not unlike water purifiers today.

Notwithstanding this rather imaginative early example, ion exchange really came into prominence in the 1940s when the invention of polystyrene-based ion exchange resin led to the efficient and much less time consuming (well, at least to those at the time) separation of the lanthanides and actinides – superseding the incredibly tedious chemical separation methods. After that ion exchange gradually became restricted to a few niche areas, particularly after the dawn of the age of analytical instrumentation in the 1960s, when atomic spectroscopy essentially took over trace metal determinations from both ion exchange and photometric methods.

Nonetheless, there was one area of inorganic trace analysis, where atomic spectroscopy was of little help, the determination of the common non-metal anions. Helped by the renaissance in liquid chromatography in the 1970s, now commonly called HPLC, Hamish Small announced in 1975 the invention of the pellicular anion exchange resin column linked to suppressed conductivity detection for the high speed separation and determination of chloride, nitrate, nitrite, bromide, sulphate and phosphate etc. This technique became known as ion chromatography and quickly became established as the main method of anion analysis, replacing the time consuming and involved chemical methods at the time. The original patents ran out some time ago and a number of companies now offer ion chromatography instrumentation containing not only suppressed and non-suppressed conductivity detection, but also other detection systems such as those based on UV-vis absorbance. Ion chromatography is now routinely used by many agencies such as water companies and environmental agencies to monitor the quality of potable, natural and wastewaters. Nitrate monitoring is perhaps the most well known example, where pollution from fertilized land run-off is a common occurrence.

Further developments and improvements in ion chromatography separation and detection are continuing as mentioned above to meet even more challenging environmental analyses. One such is the recent concern over the presence of bromate in drinking water produced by the oxidation of bromide during disinfecting procedures, particularly when using ozone. Bromate is considered highly carcinogenic and strict very low limits of less than 1 ppb have been set by a number of environmental agencies. Ion chromatography methods have been developed to achieve this, interestingly exploiting an old colorimetric procedure for highly sensitive and selective detection. This is accomplished using an on-line post column reaction where the separated bromate oxidises iodide to iodine and the absorbance measured by a UV-vis detector.

Another area where ion chromatography is likely to be increasingly used is in the monitoring of trace toxic metals. Ion chromatography instrumentation is becoming smaller and can be used in areas where atomic spectrometers will be expensive or difficult to use, or even in dangerous locations such as oil rigs. The development of new separation systems involving metal chelating ion exchange materials will also allow the analysis of samples of high salt content such as seawater and estuarine water. So, 60 years after the invention of the ion exchange resin column, predominantly for metal separations, we are likely to see ion chromatography return as an important technique for trace metal determinations in environmental systems.

Dr PHIL. JONES,
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University of Plymouth, Plymouth,
Devon PL4 8AA

Web link: Peter E. Jackson, Ion Chromatography in Environmental Analysis. In *Encyclopedia of Analytical Chemistry*, R.A. Meyers (Ed.), pp. 2779–2801, John Wiley & Sons Ltd, Chichester, 2000.
http://www.separationsnow.com/repository/pdfs/0835-_a.pdf

Phil. Jones' interests include the application of high-performance chelation ion chromatography, as illustrated by the following publications:
Shaw, M.J., Cowan, J. and **Jones, P.** (2003) Fabrication of an aurin tricarboxylic acid immobilized chelating polymer for the ion chromatographic determination of trace metal ions in highly mineralized waters. *Analytical Letters* **36**, 423-439.
Shaw, M.J., **Jones, P.** and Nesterenko, P.N. (2002) Dynamic chelation ion chromatography of transition and heavy metal ions using a mobile phase containing 4-chlorodipicolinic acid. *Journal of Chromatography A* **953**, 141-150.

Truscott, J.B., **Jones, P.**, Fairman, B.E. and Evans, E.H. (2001) Determination of actinides in environmental and biological samples using high-performance chelation ion chromatography coupled to sector-field inductively coupled plasma mass spectrometry. *Journal of Chromatography A* **928**, 91-98.
Jones, P. (2000) Major sensitivity improvements in ion chromatography determinations involving post-column spectrophotometric reaction detectors through elimination of pump noise using a dual wavelength monitoring procedure. *Analyst (London)* **125**, 803-806.
Shaw, M.J., Hill, S.J., **Jones, P.** and Nesterenko, P.N. (2000) Determination of beryllium in a stream sediment by high-performance chelation ion chromatography. *Journal of Chromatography A* **876**, 127-133.
Shaw, M.J., Hill, S.J., **Jones, P.** and Nesterenko, P.N. (2000) Determination of uranium in environmental matrices by chelation ion chromatography using a high performance substrate dynamically modified with 2,6-pyridinedicarboxylic acid. *Chromatographia* **51**, 695-700.

Evaluating air quality

Concern about the environmental impact of aircraft will be a key factor in the future development of Britain's airports. But what analytical methods are available for measuring aircraft emissions? **Kim Cooke**, a committee member of the ECG, explains the use of remote optical measurement techniques for monitoring air pollution at UK airports and other urban and industrial sites.

Remote optical measurement techniques

Remote optical measurement techniques (ROMTs) have the great advantage over other more conventional techniques for measuring gaseous pollutants in that they can perform real time, in-situ gas analysis along an open path. Although there have been notable advances in ROMTs in recent years resulting in greater reliability, more portable systems and overall decrease in cost (always a very decisive factor), there is still resistance to using them for routine monitoring of emissions and air quality. The primary reason for this is that there is still no standardisation between systems. This is highlighted particularly well in the World Health Organisation's guidelines for air quality (WHO, 2000), where four out of six of the main "classic" pollutants SO_2, NO_2, CO and O_3 can be measured using remote optical sensors. However, they point out the techniques available do not conform to ISO7996 (ISO1985b), hence stress the need to pay careful attention to instrument calibration and quality assurance to obtain meaningful data.

ROMTs have already proved their usefulness for a variety of applications, including assessing ambient air quality in urban environments monitoring concentrations of fugitive, toxic or potentially explosive gases in process plants and petrochemical sites and the measurement of motor vehicle or aircraft exhaust emissions. However, while these methods offer the advantage of being able to measure over significantly long paths, often several hundred metres, the uncertainties also associated with point measurements due to dispersion and other interfering mechanisms, become a factor. In the case of open path measurements, this has often placed doubt on the confidence in the collected data. Nonetheless, many typical applications for which remote optical sensors are used offer no superior alternative. Where the emission source is mobile and unconstrained, for example an aircraft, extractive monitoring is less attractive. A monitoring system at a runway end is a much more preferable than a measurement system fitted to each aircraft.

Remote Optical Sensing Evaluation (ROSE)

With ever more air quality legislation and national and international strategies on the horizon, governmental bodies, local authorities and industry alike are under more pressure to deploy monitoring systems in which there is a high degree of confidence in the data produced. Within the context of future standardisation legislation, a European initiative has been embarked upon to determine critical performance factors for ROMTs (CEN/TC 264/WG 18). As part of this initiative a European consortium has been formed within Framework 5's Competitive and Sustainable Growth programme to carry out a project on Remote Optical Sensing Evaluation (ROSE). The primary objectives of ROSE are the determination of "Best Practice" and performance standards, along with a firm theoretical foundation on which to support such statements (ROSE project, GR6D-CT2000-00434). It addresses the problems associated with system and certification approval by inter-comparing five diverse commercially available ROMTs under both field and laboratory conditions. The measurement techniques included differential optical absorption spectroscopy (DOAS), tuneable diode laser spectroscopy (TDLAS), Fourier transform infrared and ultraviolet spectroscopy (FTIR and FTUV), as well as differential optical absorption light detection and ranging spectroscopy (DIAL-LIDAR). Working alongside these techniques, the project also utilizes the advances in Computational Fluid Dynamics (CFD) modelling to reduce the uncertainties in the measurements induced by dispersion.

Remote optical measurement techniques used by ROSE

The ROSE project inter-compares the basic approaches, as well as focusing on a comprehensive suite of gaseous pollutants, all of which are pertinent to current and future legislation. Table 1 summarizes the instruments available to the ROSE project, as well the pollutants that can be measured.

Table 1: *Instrument type and capabilities available to ROSE*

Instrument	Pollutant	Beam path	Limit of detection
Polytron ToxLine (FTUV) *Dräger Safety GmbH*	NO_2, NO, SO_2, NH_3, O_3, benzene, toluene, ethylbenzene, xylene, (BTEX), styrene, H_2S, 1,3-butadiene	10-200m	1-30 ppm.m
Safeye 256 (IR DOAS) *Spectronix Ltd*	Total HC (C1-C8), calibrated for ethene	30-90m	0.2 LEL.m
Safeye 424 (UV DOAS) *Spectronix Ltd*	Benzene, toluene, xylene (BTX), NH_3	30-100m	8 ppm.m
Safeye 414 (UV DOAS) *Spectronix Ltd*	H_2S	30-100m	8 ppm.m
DIAL LIDAR (IR/UV) *Spectrasyne Ltd*	Benzene, toluene, p-xylene, NO etc (UV), ethene, ethane, CH_4, C_3H_8, C_3H_6, C_4s, HC-cocktails, cyclohexane, various chlorinated and sulphurous hydrocarbon species, etc, etc. (IR). Speciated HCs and aromatics with sorption tubes.	50-1200m (DOC)	5-50 ppb (DOC)
Unicam Mattson Research Series FTIR *Reading University*	H_2O, CO_2, O_3, N_2O, CO, CH_4, NO, SO_2, NO_2, NH_3, HF, HCl, SF_6, alkanes, alkenes, and alkynes, BTX	10-100m	ppm level
Bomem 100 FTIR *Sira*	H_2O, CO_2, O_3, N_2O, CO, CH_4, NO, SO_2, NO_2, NH_3, HF, HCl, SF_6, alkanes, alkenes, and alkynes, BTX	10-100m	ppm level
TDLAS (NIR) *Norsk Elektro Optikk*	CH_4, NH_3, HCl, HF (CO, CO_2, HCN, N_2O, H_2O)	Up to 100m	10-75ppm.m

(LoD: Limit of Detection; DOC: Depending on Conditions; NIR: near infrared)

Assessment of instrument performance

The diversity of remote optical techniques used in ROSE highlights the difficulty in defining comprehensive performance parameters on which to assess all the instrumentation. It therefore follows that performance parameters should be based on the application rather than the instrument itself. Performance parameters have already been defined for ambient air quality measurements by the UK certification scheme MCERTS (1998) and although ROMTs were specifically excluded, it acts as a suitable starting point. The primary performance parameters focused on by ROSE are illustrated in Table 2.

Table 2: *Performance parameters*

Performance parameters for ambient air quality monitoring instruments	Additional parameters for ROMTs
Laboratory and field repeatability (standard deviation)	View geometry/beam profile, including path limitations
Zero and span drift	Calibration technique/algorithm
Accuracy of measurement of known reference concentrations	Instrument lineshape (including effects of processing algorithms)
Detection limit and quantification limit	Effect of dispersion phenomena
Averaging of short-term fluctuations	Effect of direct solar radiation
Linear fit	Effect of obscuration phenomena (fog, smoke etc.)
Cross sensitivity to interfering substances	
Influence of atmospheric pressure and temperature	
Susceptibility to physical disturbances	

Complementary techniques

In practice, defining the performance parameters in isolation to assess ROMTs does not validate instrument performance. To be of any use, ROMTs have to be operated under real-world conditions and, in common with all monitoring techniques, are susceptible to meteorological conditions and dispersion effects, especially along the beam-path of the instrument. Thus the assessment of ROMTs has to take in to account external environmental conditions. Making complimentary meteorological measurements and carrying out numerical modelling of the site where the instrumentation is set up aids the understanding of the external parameters involved. Thus definition of 'Best Practice' in the positioning and use of remote optical sensing instruments is of paramount importance to limit the effect of environmental conditions on data obtained. Numerical and physical modelling techniques are particularly useful tools in this area.

ROSE field trials

In order to assess the instruments available to the ROSE project under real conditions a number of field trials were embarked upon. The sites were chosen specifically with the instruments in mind, rather than focusing on a specific measurement problem. Over the last two years four field trials have been carried out at two industrial sites, in an urban street canyon, and at an airport.

The first field trial took place in the winter of 2001 at an ethylene cracking plant in the UK. All the ROSE systems participated, and it was an ideal opportunity to look at obscuration phenomena i.e. fog. The field trial was a success in that a great deal was learnt about the instruments and they had to perform far from ideal conditions.

The next field trial took place in the late spring of 2002 at the largest producer of liquefied petroleum gas (LPG) in Europe, based in Norway. This was a very "clean" industrial site, which allowed the instruments to be tested close to their limits of detection under a variety of different meteorological conditions.

An urban street canyon in Bremen, Germany was chosen as the third site for a trial, which took place in the winter of 2002. Here carbon monoxide was the main species of interest, as this is an important gas in terms of local air quality. There was good agreement between the instruments measuring carbon monoxide with the concentrations being highly dependent on traffic volume. It is interesting to note that the long path measurements (Sira & Reading FTIR) exhibited a greater correlation with traffic volume than the point measurements.

The fourth and final field trial was held this summer at Gatwick airport. The instruments were set up at either side of the taxiway, so that emissions from aircraft could be measured directly, as they passed through the beam-path. Some work was also done to look at the emissions at take-off and landing of aircraft. The results from this field trial will be known later this year.

Conclusions

ROSE is in the process of carrying out work in the area of quality assessment and control methodologies for remote optical measurement techniques, as part of the measurement and testing activities in Framework 5's Competitive and Sustainable Growth programme (1999). The work out to date will support future European legislation concerning the use of remote optical sensing instruments, and help to provide a basis for harmonisation of these techniques. The project focuses on increasing the available knowledge about ROMTs and thereby aids the provision of a common standard to support future legislative frameworks. This will allow remote optical measurement techniques to be used more widely in enforcement or compliance monitoring applications. Only once it is possible to achieve type approval against a published European or International standard, will it be acceptable for the enforcement agencies involved to act on the basis data from remote optical measuring instruments. The aim of ROSE is therefore to be able to demonstrate through type approval that remote optical instruments perform with a defined level of certainty, and through certification testing to demonstrate that specific instruments are compliant.

Acknowledgements

The ROSE (Remote Optical Sensing Evaluation) project, project contract no. GR6D-CT2000-00434 is funded by the European Commission's Competitive and Sustainable Growth Programme.

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Web link: Remote optical measurement techniques http://rose.primariatm.ro/rose_04.html

EPA *Framework for Metals Risk Assessment*

The December issue of the *Journal of Environmental Monitoring* features an article on the United States Environmental Protection Agency's (EPA) *Framework for Metals Risk Assessment*. The complete article has been kindly made available to the Environmental Chemistry Group, and is available as a Web link to the electronic version of this edition of the *ECG Bulletin*.

The U.S. EPA has a series of programs for deciding whether and how to regulate metals based upon their toxicity. These decisions can include setting regulatory standards for environmental releases, establishing safe levels in different environmental media, and setting priorities for regulatory or voluntary efforts. In order to ensure a consistent scientifically valid approach to conducting risk assessments of metals, the U.S. EPA has undertaken the development of a *Framework for Metals Risk Assessment* to standardize the assessment processes across the various Programs and to increase the scientific validity of regulatory decision-making. As a first step in this process, the U.S. EPA developed a peer reviewed *Metals Action Plan* that lays out the areas where metals differ significantly from organic substances in their environmental fate or effects, and provides a path forward for developing cross-Agency guidance. The five main areas are:

1. Bioavailability and Bioaccumulation of Metals
2. Ecological Effects of Metals
3. Metal Exposure Assessment
4. Environmental Chemistry of Metals
5. Human Health Effects of Metals

The U.S. EPA commissioned the development of *Issue Papers* on these areas and solicited public input through invited workshops and by open public comment periods. The resulting draft papers demonstrate the complexities of conducting metals risk assessments. These issues as well as the scope and process for developing a U.S. EPA *Framework for Metals Risk Assessment* are described in the *Journal of Environmental Monitoring* article. The article's authors are all members of a technical workgroup in the U.S. EPA's Risk Assessment Forum in the Office of Research and Development.

Web link: EPA *Framework for Metals Risk Assessment*

Web site review

This is the first in a series of short reviews of web sites that are of potential interest to Environmental Chemistry Group members.

www.scienceinthebox.com

http://www.scienceinthebox.com will be familiar to ECG members who attended the joint meeting with the Analytical Division East Anglia Region on 'Ecotoxicology – Monitoring and Caring for our Environment' in Cambridge last October, where one of the authors (Erwan Saouter, Proctor & Gamble) described the site. The aim of http://www.scienceinthebox.com is to explain to a wider audience, outside the scientific community, human & environmental risk assessment and life cycle assessment.

So, is this a useful scientific and educational site or just a clever marketing tool? I believe that it is largely the former and a useful resource for students, environmental scientists and consumers (although this area is a little more commercial), who may have an interest in detergents, and other consumer products, and their impact on the environment.

The site itself is structured in layers with the top three layers contain basic information for a general audience. However, the deeper levels are more technical and detailed. The site includes six main sections:

- Product information
- Safety
- Research and development
- Sustainability
- Scientific publications; and
- Programmes and commitments.

There is a glossary of technical terms and chemical functional definitions. A particular useful feature is the scientific publications section - a list of 538 publications with a search facility (author, year of publication, scientific journal, title, keywords and abstract). Although only the abstract is provided, the full reference is quoted to facilitate access to the full article.

One of the features I found most interesting, however, was the section on Special Topics. This has two sections, the first on 'Partnerships and Programmes', which covers links with other organisations, and academia and the second entitled 'Science at a Glance'. This latter section is a series of articles, based on a set of questions and answers, about detergents and cleaning products. One example from this section covers 'natural' and 'synthetic' surfactants. This is a thirteen page overview covering structures, usage, production, biodegradability (with data), toxicity, life cycle analysis, energy use, waste steams, environmental impact and some references for further reading. Although this is not research level material, it does provide a lot of useful background information. Other parts of the web site cover issues such as the methodology to access human and environmental safety and product and chemical safety data.

If you are interested in detergents and cleaning products, and their impact on the environment, I would suggest that this web site is well worth a look.

STEVE HILL,
University of Plymouth
December 2003

News of the RSC's Environment, Health and Safety Committee

Dr Steven Lipworth has recently taken over responsibility at Burlington House for coordinating the work of the Environment, Health and Safety Committee (EHSC). Steven has experience as a policy analyst and a scientific adviser in the public and private sector, having previously qualified with a Masters degree in marine environmental toxicology and a Doctorate in environmental economics and policy. In 1997 he was awarded a three-year Wellcome Fellowship to conduct science and technology policy research projects at the Royal Society, and during this period Steven co-ordinated several ad-hoc working groups that formulated submissions in response to Government and Parliamentary Select Committee enquiries.

Recent activities of the EHSC include a revision of its Notes on *COSHH in Laboratories* and on *Individual Legal Responsibilities for Health and Safety at Work*.

An EHSC Working Party on the EU's **REACH regulations** has developed the RSC's position on this controversial legislation. The Society's position on REACH can be summarised as follows:

1. The European Commission proposal for a new regulatory framework for the control of chemicals is arguably the most significant development on controlling chemicals in the European marketplace for many decades. Under the proposed new system called REACH (**R**egistration, **E**valuation and **A**uthorisation of **CH**emicals), enterprises that manufacture or import more than one tonne of a chemical substance per year would be required to register it in a central database. REACH gives greater responsibility to industry to manage the risks from chemicals and removes the distinction between 'existing' (listed in the 1981 EINECS inventory) and 'new' chemicals.
2. The RSC finds the latest version of 'REACH' to be more balanced and more pragmatic than earlier versions. However, we still have significant concerns about the workability of some aspects of the proposal and the resources and expertise available for coping with REACH. In principle the Society would welcome a single harmonised regime for assessing and controlling the effects of chemicals on health and the environment.
3. Among the key issues that the Society would like to stress are that:
   a. REACH is based on risk rather than on intrinsic hazard alone, as hazard is not a good measure of the actual threat that a substance poses to humans or the environment.

b. REACH should be compatible with existing and proposed international initiatives on the control of chemicals.

c. REACH should only require data that has real value. This is particularly true for 'existing chemicals' that have been in use for many years with no apparent adverse effects.

d. One particular concern is that REACH could lead to useful chemicals ceasing to be available because they generate insufficient profit to cover the cost of testing.

e. The Society fully supports the principle of transparency under REACH. However, a balance needs to be found between transparency and commercial confidentiality.

f. REACH should not inhibit innovation. If the Commission equates innovation with substitution, this strategy is unlikely to lead to true innovation.

The Environment, Health and Safety Committee is the RSC's focus for professional and policy aspects of the environment, health and safety. The committee aims to:

- Provide a service to members by answering members' e-mail, postal and telephone enquiries and by publishing guidance booklets and short papers.
- Make representations in the public interest to ensure that public policy and legislation are based on good chemical science.
- Ensure that public awareness of health, safety and environmental issues is based on a proper understanding of the chemistry involved, e.g. by producing publications aimed at the public and professional briefs to help members disseminate information on topics of public interest.

For further information on EHSC activities and publications, please contact:
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Forthcoming events and symposia

20 February 2004
Analysis for Endocrine Disruptors
At the Central Science Laboratory, Sand Hutton, York. Organised by the N. E. Region of the RSC's Analytical Division. For further details contact Warwick Anderson, CSL, York on 01904 462561 or w.anderson@csl.gov.uk or Mic Daniel, Environment Agency, NLS, Leeds on 0113 2312003 or mic.daniel@environment-agency.gov.uk.

24 February 2004
RSC John Jeyes Endowed Lecture
The Role of Ocean-Atmosphere Exchanges in the Chemistry of the Earth
Professor Peter Liss (UEA)
At the University of Wales, Swansea. For further details contact, Dr Peter Douglas on 01792 205678 or p.douglas@swansea.ac.uk

26 February 2004
Radioactive Waste and Environmental Molecular Science
Professor Francis Livens (Radiochemistry Centre, University of Manchester).
At the Chase Hotel, Whitehaven, Cumbria. Organised by RSC Cumbria Section. For further details contact Alex Jenkins on 01946 774597 or aj42@bnfl.com

1 March 2004
The Changing Atmosphere
Dr Paul Monks (University of Leicester)
At Keele University, Staffordshire. Organised by the RSC North Staffordshire Section. For further details contact David McGarvey on 01782 584142 or d.j.mcgarvey@chem.keele.ac.uk

2 March 2004
Environmental and Human Health Impacts of Endocrine Disrupting Chemicals
At SCI International Headquarters, 14/15 Belgrave Square, London SW1X 8PS. Organised by SCI Bioactive Sciences Group. For further details contact Dr Richard Greenwood on 02392 842065 or richard.greenwood@port.ac.uk

3 March 2004
ECG Distinguished Guest Lecture & Symposium
Environmental Chemistry From Space
At the Linnean Society of London, Burlington House, Piccadilly, London. Speakers are Professor John Burrows (University of Bremen), Professor Jim Aiken (Plymouth Marine Laboratory) and Dr Paul Monks (University of Leicester). For further details contact Michael Leggett on 02089967107 or mike.leggett@bsi-global.com

10 March 2004
The Role of Ocean-Atmosphere Exchanges in the Chemistry of the Earth
At the University of Aberdeen. Organised by the RSC Aberdeen and North Scotland Section with Professor Peter Liss, University of Anglia as the main speaker. For further details contact Marcel Jaspars on 01224 272895 or m.jaspars@abdn.ac.uk

29 & 30 March 2004
Environmental Technology: Diagnostics
At Herriot Watt University, Edinburgh. Organised by the RSC Water Science Forum. For further details contact Kevin Prior on 01535 635128 or rsc@cookprior.co.uk

20 & 21 April 2004
Monitoring Indoor Air Pollution (MIAP): 2nd International Conference
At Manchester Metropolitan University. Organised by ISBE with the support of ARIC. For further details contact Dr Ivan Gee on 0161 2471592 or I.L.Gee@mmu.ac.uk or visit www.doc.mmu.ac.uk/aric/conference/miap2004.html

25 June 2004
Young Environmental Chemists Meeting 2004
At Sira, Chislehurst, Kent. Organised by the RSC Environmental Chemistry Group. For further details contact Dr Kim Cooke, Sira Technology Ltd on 020 8468 1720 or kim.cooke@sira.co.uk

Society for Environmental Geochemistry and Health
22nd European Conference

SEGH 2004

SEGH 2004 will be hosted by **Sussex University** on 5 & 7 April 2004. Lectures and posters will be presented on all aspects of environmental geochemistry, and its impacts on health. Contributions on the characterisation and remediation of contaminated land, and on studies of organic contaminants in any setting, will be especially welcome. Papers are invited from students and post-doctoral fellows, as well as from established researchers. Prizes will be awarded to the best oral and poster presentations by postgraduate research students.

Registration and Abstract Submission Details

The deadline for abstract submission and cheap/early registration is **February 20th 2004**. The abstracts format should be downloaded from the web site and submitted as e-mail attachments to: SEGH2004@sussex.ac.uk.

Further details including a registration form, and how to apply for a limited number of student bursaries, can be obtained from the web site: http://www.sussex.ac.uk/conferences/segh/

ROYAL SOCIETY OF CHEMISTRY

RSC Environmental Chemistry Group

Young Environmental Chemists Meeting 2004

25th June 2004

@ Sira, Chislehurst, Kent

The meeting is intended as a forum for young environmental chemists to present and discuss their research and to meet fellow researchers.

For further information contact:

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Book review

The Clean Air Revolution: 1952 to 2052. Marking 50 years since the Great London Smog

Clean Air and Environmental Protection, Winter 2002, **32** (4), pp 75, £10.00.
ISBN 0903 474 56 5 (www.nsca.org.uk)

This publication has been produced by the National Society for Clean Air and Environmental Protection and consists of thirteen short chapters on air pollution and related legislation in the UK.

Part One consists of four chapters that review UK air pollution from 1952 – 2002. Chapter One ("The Great London Smog – Effects and Repercussions" by Peter Brimblecombe) reviews the circumstances and context of the 1952 December smog and reflects on its impact on legislative attempts to improve air quality. Derek Elsom ("Smog – more than a London Problem") then discusses pollution episodes all over the UK pre-2002 with an excellent introduction to late-19th and 20th century aspects of air pollution.

Part Two is rather more complex, covering 2002 – 2052 and sets out the challenges that face governments across the world now that the implications of transboundary pollution are being realised. There are chapters dealing with key pollutants (PM_{10}s, ozone), their impacts on health and ecosystems, and some of the work underway on new fuels and new sources of pollution. Roy Harrison's contribution ("Key Pollutants – Airborne Particles") is authoritative and succinct and the chapters on ozone (Derwent *et al*) and health (Robert Maynard) are excellent introductory articles. Longhurst *et al* discuss the reductions in air pollutants over the UK whilst Richard Mills advises against complacency, as industrial and technological improvements may be over-ridden by increased numbers of vehicles on the roads.

This NSCA publication is concise and informative. The illustrations are well chosen and illuminating and there are a number of good web site references. The book is an excellent teaching resource and would be valuable for sixth forms, colleges and introductory HE courses. The publication is well referenced throughout and uniquely affordable at £10.

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New books on the environment from the RSC

Published in 2003

Sustainability and Environmental Impact of Renewable Energy Sources
Issues in Environmental Science & Technology, No. 19
R. E. Hester and R. M. Harrison (eds.)
£45.00 (Members' price: £29.25)
http://www.rsc.org/CFbooks/issueindex.cfm?BID=IS003019

Catalysis in Application
(Proceedings)
S. D. Jackson, D. Lennon, J. S. J. Hargreaves (eds.)
£99.95 (Members' price: £64.75)
http://www.rsc.org/is/books/catinapp.htm

Plasma Source Spectrometry: Applications and Emerging Technologies
(Proceedings)
J. G. Holland and S. D. Tanner (eds.)
£99.95 (Members' price: £64.75)
http://www.rsc.org/is/books/plasmasource.htm

Chemical Formulation: An Overview of Surfactant Based Preparations Used in Everyday Life
A. E. Hargreaves
£23.95 (Members' price: £15.50)
http://www.rsc.org/is/books/chemform.htm

Environmental Radiochemical Analysis II
(Proceedings)
P. Warwick (ed.)
£99.95 (Members' price: £64.75)
http://www.rsc.org/is/books/radiochemical.htm

To be published in 2004

Hyphenated Techniques in Speciation Analysis
(RSC Chromatography Monographs)

£79.95 (Members' Price: £51.75)

Water Contamination Emergencies: Can We Cope?
(Proceedings)
K. C. Thompson (ed.)

Mass Spectrometry: A Foundation Course
K. Downard

Meeting report: International conference on chrysotile asbestos-cement products

John Hoskins, Editor of *Journal of Indoor and Built Environment*, who represents the Occupational and Environmental Toxicology Group on the ECG Committee, reports on a conference held in November 2003 at the Taj Palace Hotel, New Delhi, India.

I was recently invited to speak at an International Conference on Chrysotile Asbestos-Cement Products hosted by the Indian Asbestos-Cement Products Manufacturers' Association. It was a large meeting attended by around 240 delegates with representation from all the major producing countries. The calm and scientific atmosphere of the meeting was a wonderful change from the ignorance and hysterical pseudo-science that accompanies any mention of asbestos at a meeting in the UK. We know that the air we breathe often contains a considerable burden of unwanted pollution but why the presence and concentration of one of the very minor components should become a *cause célèbre* in a several countries is difficult to explain. Exposure to asbestos in the UK is now widely considered to be a brush with death. All the asbestos types have been thoroughly demonised through an orchestrated attack by the media, lawyers and asbestos removal contractors, peddling any number of stories few of which have any truck with scientific reality. The result is that there is now great public fear and trembling whenever the name asbestos is mentioned.

The study of exposure to airborne mineral fibres is a fascinating one and research on the subject is very active. Regrettably, the results of this work are not widely disseminated in this country and are largely ignored by legislators and the courts, who have set themselves up as protectors of the common herd – although there are at last signs that their intransigence is weakening. Asbestos is said to be a dangerous material, and without doubt some types in some forms certainly are very dangerous to health. Chrysotile Asbestos-Cement Products where a small amount of fibre is bound in a cement matrix are not dangerous, every study of them from manufacture to disposal agrees. Occupational health studies have always given them a clean bill of health. However, vested interests selling alternative products have won a EU wide ban on their production. The reason for the ban, which is going ahead against the wishes of several EU countries, is not because member countries are following some green agenda or have concern for the health of their people it is because there is money to be made by doing so. At least for those countries, principally France and Germany, who will benefit the most and who have driven the process forwards. UK legislation hot on the heels of the ban has invoked the criminal law. To expose others, it seems, to even the sight of an asbestos product, is now a major crime punishable by severe penalties. Experience is showing that too often the case for the prosecution requires rather less evidence than that needed in the middle ages to secure a conviction for witchcraft. I do not exaggerate.

None of this is to dismiss the risks of exposure to some asbestos types but there is science and there is junk science. Here is the science. The commercial name asbestos refers to six natural mineral fibres. Five of these are amphiboles [silicate and aluminosilicate minerals which form fibrous or columnar crystals] including crocidolite or blue asbestos.

These minerals are no longer produced. The sixth mineral is a serpentine mineral chrysotile or white asbestos, which accounts for some 98% of all asbestos ever mined.

Asbestos minerals have been mined for over a century although only type, chrysotile (white asbestos), is mined today – but that still in millions of tonnes per annum. An unfortunate legacy from uncontrolled early use is an epidemic of disease resulting from exposure to, in particular, amphibole types of asbestos. The lungs are delicate organs and their physical assault by abrasive minerals can cause permanent damage that may lead to cancer. Durable mineral fibres seem particularly good at causing such damage because their morphology makes removal difficult. As a consequence amphibole asbestos types, which are extremely durable in the lungs, are now banned in most countries of the world, although interestingly not in the USA, but there are severe limitations on use. The case for banning amphibole materials is sound, that for banning chrysotile is much less so. As noted, the moves to ban all asbestos types rides ahead of so-called alternative products; cellulose and mineral wool insulants, galvanised iron and other types of corrugated sheeting, plastic pipes and a host of other products. These are invariably more expensive than similar chrysotile products, provide often inferior replacements and have a health and safety record no better, and often worse than the materials they are replacing.

In the beginning of the modern phase of asbestos mining and production the high level of pneumoconiotic disease associated with dusty trades such as asbestos textile manufacture was put down to tuberculosis and this undoubtedly was a confounder. Data suggesting that asbestos might also be implicated in lung cancer accumulated slowly over the years. But it was not until the classic paper of Wagner in 1960 giving data from South Africa, which showed that there was a considerable excess of the rare tumour mesothelioma in people, who worked in, or lived downwind of, crocidolite mines, that real concern was shown. For the first time it was realised that people who did not work with asbestos but who lived near a crocidolite mine were sufficiently exposed to develop disease.

The American government went over the top and published a report from the Occupational Health and Safety Administration (OSHA) based, so far as can be established on no facts whatsoever, saying that there would soon be 2,000,000 asbestos related deaths per annum in the US. The fears were awakened of a world pandemic of asbestos related deaths by the year 2000 as a result of the increase in ambient levels. Fortunately such a disaster has not materialised nor on the available facts was it ever remotely likely.

Unfortunately, the result of the scare-mongering is the situation we have today where there exists in the public mind the idea that all asbestos minerals are dangerous and worse still that they are dangerous at extremely low exposure levels. There is no rational or scientific basis for this belief.

Outside of Europe, some 90% of the countries of the world still regard chrysotile as a material of commerce. Whether it will remain so depends on how politically independent the countries are and whether they can see through the machinations of the EU parliament. Countries such as India are much influenced by 'mother England'. However, initial worries in India, following on from the EU ban, have been overcome. It is accepted that the health effects are largely the result of earlier applications where there was indiscriminate use bereft of pollution controls and that amphibole products were largely to blame. The Supreme Court of India has thrown out claims against asbestos cement on the grounds that the petitioners could not supply evidence that the materials were dangerous to health. (A similar situation to that in the USA where attempts to ban chrysotile products were thrown out by the Fifth Court of Appeal, in part on the grounds that the plaintiffs, the EPA, could not show that alternatives were any safer when it was demonstrable that in some cases they were less so. Also in Brazil, one of the largest producers and users of chrysotile, where, in June 2001, the Supreme Court rejected a petition by activists to ban asbestos cement production.)

The importance of asbestos cement to India lies in an industry that supplies important components for developing the infrastructure of the poorer parts of the country. While the economies of Western countries are governed more by labour than material costs the opposite is the case in India. Here, materials costs are of the essence. Greater materials costs means the difference between a village getting clean piped water or not or a family having a home or not. At the present time the asbestos cement industry is providing affordable materials that perform better than the alternatives. Consider which is more preferable, life in a hut made of corrugated sheeting with an outside temperature of 45˚C when the hut is made from galvanised iron or from cement. Then consider another common fact of Indian weather: in a cyclone corrugated iron sheeting ripped from roofs is a deadly weapon, cement sheeting shatters and presents a fraction of the danger. The cement huts also last about ten times longer than the iron ones.

Finally, look at anomalies created by the most important recent studies. It has long been known that the main reason why chrysotile is comparatively harmless compared to the amphiboles is its low durability in vivo. Short fibre chrysotile has been shown to be cleared from the lungs over a matter of days (amphiboles may never clear). This has been known for a long time. Now, a long fibre chrysotile produced in Brazil has been shown to be largely cleared in a day. Most chrysotile is cleared quicker than glass and mineral wools and much quicker than ceramic fibres. These materials, although also suspect human carcinogens, are the preferred higher cost alternatives. The clearance of chrysotile is well within the time defined for materials classified as nuisance dusts.

India is to be congratulated for listening to the science and looking to the pressing needs of its vast population. Closing addresses at the meeting by Shri Sahib Singh Verma, Minister of Labour and Shri Bandaru Dattatreya, Minister for Urban Development and Poverty Alleviation show the importance attached to the meeting by the Indian Government. 'Mother England' must live with her nose cut off.

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December 2003

Meeting report: Monitoring exposure to air pollution

" ... the air ... this brave o'erhanging firmament, this majestical roof fretted with golden fire – why, it appeareth no other thing to me than a foul and pestilent congregation of vapours.**"**

Hamlet, Prince of Denmark: Act 2, Scene 2

The RSC's Automation and Analytical Management Group – part of the RSC Analytical Division – held a conference on **Monitoring Exposure to Air Pollution** in December 2003 at the English Heritage Lecture Theatre, London. The meeting was held with cooperation from the National Physical Laboratory, the Building Research Establishment (BRE) and the Joint Research Centre (Ispra, Italy). Twenty speakers and fifty delegates, including **Leo Salter**, participated.

The opening session considered **Health issues and indoor air from a UK and EU perspective** and Session 2 (**health, exposure and sources**) also focussed on indoor air quality with papers on **house dust, VOCs (volatile organic compounds), radon, and indoor air monitoring techniques**. Thursday's sessions examined **sick building syndrome (SBS), ventilation, building materials**, and more **aspects of indoor air monitoring** (e.g. calibration, QA/QC). The closing presentations re-emphasised the importance of **VOCs for indoor air quality assessment** and the final paper discussed **the monitoring of environmental tobacco smoke** (ETS).

Five posters were displayed covering BTEX (benzene, toluene, ethylbenzene, xylene) measurements; Ni, As, Cd and Pb assessment in air using voltammetry; chemical risk analysis in an elementary school (Spain); indoor/outdoor nitrogen dioxide and benzene assessment; and "Breath analysis to assess exposure to trihalomethanes in drinking water".

Indoor air pollution is sourced from furniture, dust mites (*Der p* allergen), glues, fires, cooking and tobacco smoke and is manifest as nitrogen dioxide, carbon dioxide, carbon monoxide, formaldehyde (and many other VOCs), asbestos (and other fibrous materials) and radon. Fungi, bacteria, chlorinated organic compounds (e.g. pesticides) also have impacts on indoor air quality (IAQ). It is apparent that although indoor air pollution is sometimes perceived as a lesser risk than that from outdoor air, 70-90% of exposure to air pollutants occurs indoors. For the individual the distinction is between perceptions of individual choice i.e. voluntary exposure indoors and involuntary exposure outdoors (no choice). This is an important distinction when it comes to the design of prescriptive statutory instruments for the control of IAQ – especially, though not exclusively, in relation to ETS. At risk groups (the old, the young, the sick, the bedridden) can suffer from exposure to indoor air pollutants. For instance, 67% of benzene exposure occurs at home – 22% by day and 45% by night (Paul Harrison, University of Leicester). For all VOCs the mean indoor concentrations are most frequently between 1.5 and 2.5 times higher than those measured at the corresponding outdoor sites and on average between 30% and 55% of VOC concentrations found indoors originate from indoor sources. (E. Goelen, Vito, Boeretang 200, B-2400, Mol, Belgium)

In the UK there is a need for IAQ guidelines similar to those operating in Canada, Finland, Germany and elsewhere. A Department of Health paper "Indoor Air Quality Guidelines" has been approved for publication in summer 2004. Revision of Building Regulations and Housing Fitness Standards is ongoing. Paul Harrison suggested www.le.ac.uk/ieh/ukieg/htm/ (the UK Indoor Environment Group site) and http://wads.le.ac.uk/ieh/ierie/index.htm (the web site for the Inventory of European Research on the Indoor Environment) as useful sources of information. European reports such as EUR 16123 EN 1995 for radon, EUR 18698 EN 1999 for VOCs and EUR 19529/EN 2000 (Risk Assessment and IAQ) were also mentioned (Christian Cocket, Centre Scientifique et Technique du Batiment, Paris, France).

Techniques and standards for indoor air pollutant monitoring have yet to be established. Derrick Crump (BRE, Watford, WD25 9XX) suggested that in relation to this, information could be accessed from Crump, D.; Raw, G.; Upton, S.; Scivyer, C.; Hunter, C.; Hartless, R. (2002) "A protocol for the assessment of indoor air quality in homes and office buildings" BRE Report 450, CRC Ltd., London and companion papers: Crump, D. (2001) "Strategies and protocols for indoor air monitoring of pollutants" *Journal of Indoor and Built Environment* **10**, 125-131 and Mohle, G.; Crump, D.; Brown, V.; Hunter, C.; Squire, R.; Mann, H.; Raw, G. (2003) "Development and application of a protocol for the assessment of air quality" *Journal of Indoor and Built Environment* **12**, 139-149. Several ISO documents (ISO/DIS 16000-1 to 16000-8) are also relevant.

Exposure to **airborne particulate matter** can be high indoors (Rob Kinnersley, EA). Unlike the situation with carbon monoxide and nitrogen dioxide the concentrations of outdoor airborne particulate matter are only weakly linked to indoor concentrations (concentrations of particles of diameter 0.1micrometres – 0.2 micrometres are the most closely associated). But it is noteworthy that there can be large variations between individual exposures to pollutants such as NO_2, CO and particulates. These variations are associated with an individual's micro-environment and with individual activity levels (individuals have a 'personal cloud' of particulate matter of around 16 micrograms per cubic metre).

Radon in the environment was tackled by Jon Miles (NRPD) who gave an excellent overview of radon in UK housing. Heated domestic dwellings draw in external air (and radon from

bedrock) at a rate of up to 2 m^3 an hour. Survey data on 450 000 houses (living rooms and bedrooms) indicated that there are 100 000 homes in the UK above the Action Level (200 Bq m^{-3}) and for which remedial action (sump and fan at £700-£1000 cost) is required. Current Building Regulations and changes in standard conveyancing questions (to include radon) mean that new houses and houses new to the market will reduce the affected UK housing stock.

Together with the control of pollutant sources ventilation is a crucial element in controlling **indoor air quality** (IAQ) (Bridget Pierce, BRE), There is a synergism between IAQ and ventilation – too often air conditioning is seen as a simple heating/cooling system and its role for determining IAQ is overlooked. Water vapour is seen as a major domestic pollutant (it causes condensation, mould growth, the mobilisation and reaction of building and furnishing chemicals etc.). To keep the Relative Humidity of the average domestic building below 70% at least 0.5 ach (air changes per hour) are needed. It was suggested (Jan Kristensson, Chemik Lab, AG, Norrtalje, Sweden) that SBS may well be strongly linked to indoor water concentrations in that reactions between water and chemicals present indoors could produce a potent mix of chemicals. Water (liquid and vapour) could also play a role in transporting such chemicals and breakdown products to the lungs.

VOCs indoors range from acetylene to n-C_{16}, semi-VOCs from n-C_{18} to n-C_{40} and can consist of hydrocarbons, acids, halocarbons, alcohols, aldehydes etc. VOCs have various odour thresholds and individuals have various sensitivities. Speciated VOC monitoring (as opposed to total VOC (TVOC) measurement) is invariably required and the most commonly used protocols rely on active pumping of known volumes of air through absorbents such as Tenax or passive sampling onto activated charcoal. This is followed by thermal desorption with GC-MS for separation and identification. Many of the species present will be at concentrations down to sub-ppb levels. Bob Large (M-Scan Ltd., Wokingham, RG41 2TZ) discussed the ways in which the specific distribution of organic air pollutants reflects closely the particular indoor atmosphere and how (when absorbed onto clothing or other materials) this can be used forensically to provide a 'fingerprint' ('signature') of that particular environment. The smoky pub environment (nicotine, vinyl pyridine, menthol, ethanol, phytol, isoprene, limonene, BTEX.), cooking odour (garlic) (diallyl disulphide, allyl mercaptan, allyl methyl sulphide, dimethyl disulphide), air freshener (3,5,5 – trimethylhexanol, limonene, 4-hexen-1-ol acetate) were given as examples in this interesting and informative paper.

Ivan Gee (Manchester Metropolitan University) presented a clear and interesting description of work that sought to evaluate the effectiveness of the voluntary measures (ventilation and non-smoking areas) used in pubs and bars to reduce **environmental tobacco smoke** (ETS). ETS is made up of mainstream smoke (inhaled/exhaled) and sidestream smoke (smouldering cigarettes) emissions. Using absorbent tubes and GC-MS and (amongst other chemical markers) solanesol as an ETS specific marker of ETS particulate matter and 3-ethenyl-pyridine as a tobacco specific VOC marker (nicotine is problematic because of its high rate of surface adsorption) it was found that non-smoking areas experienced an average reduction of 27% in ETS $PM_{2.5}$, a 53% reduction in solanesol particulate matter and a 63% reduction in nicotine as compared with smoking areas. Ventilation systems because they were not specifically designed for ETS extraction and/or because they were frequently not switched on, had no statistically significant effect on ETS.

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Book review

Minamata: Pollution and the Struggle for Democracy in Post-war Japan
Harvard East Asian Monographs 194

Timothy S. George

Published by Harvard University Asia Centre. Distributed by Harvard University Press, Cambridge, Massachusetts & London, 2001, pbk 2002, pp 385, £16.50

"One cannot study Minamata only by teasing truths out of musty documents in archives, nor can the scholar pretend to be a detached observer when he cries along with his subjects as they tell their stories."

In the opening lines of the Acknowledgements to his book, Timothy George clearly indicates where his sympathies lie but does himself an injustice when he reflects on the objectivity of his text. The book is *". . . an outgrowth of my 1996 Harvard PhD thesis in history."* and, as such, conforms to the academic norms of that discipline. Although the language is strong it is not a polemical book,

"Minamata is a story not just of the environmental and human costs of rapid 'modernization', but also of a callous and murderous corporation hiding its guilt; of the collusion and confusion at all levels of government and society, including the scientific community and the media . . ." (p7)

The book describes three rounds of response to Minamata disease. The first begins with its 'discovery' (1956) and a settlement (1959). After 1959 changes in Japan and Minamata led to a more complete settlement and, finally, a third 'full' solution was agreed in 1995. As Timothy George writes, "A society's responses to an environmental disaster say a great deal about it" and the changes in settlements over the 1959-1995 period reflect the contemporary political and social changes in Japan. He explains that Minamata has been governed by three "feudal lords" – the Sagara Family (13th to 16th centuries), the Fukami Family (16th to 19th centuries) and the Nitchitsu factory in the 20th century. There are parallels between 20th century Minamata and 19th century Britain – social classes, class discrimination and "an oppressive "feudal" structure of discrimination". The various financial settlements agreed

with the victims of Minamata disease (and those fishermen whose livelihoods suffered because of lost catches and unsellable fish) parallel changes in 'worker consciousness' in Japanese society as a whole.

Timothy George describes in great detail this struggle for compensation and much of his discussion has generic value for the interpretation of any major pollution incident. He delineates the way in which the development of the Minamata industrial base from calcium carbide manufacture to nitrogen fertilizer production, its links to cheap hydroelectric power and crucially, its role in the provision of acetaldehyde (from acetylene blown over mercuric sulfate) became nationally important for Japan's economic growth. In consequence, the Government and industry supported alternative explanations to organic mercury for the environmental effects (thallium, pesticides, explosives from WWII, red-tide). Action was therefore delayed and knowledge of the factory as the direct source of organic mercury was hidden from the mid-1950s until 1995.

Although the detailed archival evidence of the day-to-day negotiations presented in the meat of the book is somewhat tedious it is nevertheless essential for an understanding of the complexity of the legal, socio-cultural, political and economic issues that surround the environment. For instance,

" . . . too many scientists seem to have been in the service of money and power. Too many in the media saw it as their duty to be 'neutral' by uncritically reporting every theory, rather than investigating who sponsored them and whether they were backed by solid evidence. Too many government officials seem to have been willing to sacrifice poor fisher folk on the altar of high growth." (p70)

"From this time until the present, diagnosis and certification of Minamata disease patients have been as much political and financial issues as medical questions." (p112)

George's final chapter *("Minamata and the Tragedy of Japan's 'Modernity'")* reflects on the spiritual cost to rural Japanese society of material progress.

Although it is overly long and sometimes sententious (perhaps because of its origins as a PhD thesis), the impact of this book is in the exhaustive presentation of the slow accumulation of evidence and pressure which brought some form of recognition to the victims. It is a book for individual study; any lecturer dealing with environmental issues should know it - as should other environmental professionals. Whether students would read it is another issue . . . .

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Recent books on the environment and on toxicology at the RSC library

The following books and monographs on environmental topics, toxicology, and health and safety have been acquired by the Royal Society of Chemistry library, Burlington House, during the period July to December 2003.

Arsine: Human Health Aspects

Czerczak, S., WHO International Programme on Chemical Safety (IPCS), Geneva, 2002, ISBN: 9241530472

Dioxins and Health: 2nd Edition

Schecter, A., Wiley-Interscience, 2003, New York, ISBN: 0471433551

Contact Sensitisation: Classification According to Potency

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), Brussels, 2003.

ENDS Environmental Consultancy Directory 2003: 10th Edition

Environmental Data Services (ENDS), London, 2003, ISBN: 0907673201

Environmental Radiochemical Analysis II: Proceedings of the 9th International Symposium on Radiochemical Analysis

Warwick, P. (ed.), Royal Society of Chemistry, Cambridge, 2003, ISBN: 0854046186

Environmental Risk Assessment of Difficult Substances

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), Brussels, 2003,
ISBN: 0773807288

Handbook of Elemental Speciation

Cornelis, R., Caruso, J., Crews, H., Heumann, K., J. Wiley, Chichester, 2003, ISBN: 0471492140

Off-flavors in Aquaculture

Rimando, A.M., Schrader, K.K., American Chemical Society, Washington, D.C., 2003, ISBN: 0841238219

When Smoke Ran Like Water: Tales of Environmental Deception and the Battle Against Pollution

Davis, D., New York, Basic Books, 2002, ISBN: 0465015211

Wood Deterioration and Preservation Advances in Our Changing World

Goodell, B., American Chemical Society, Washington, D.C., 2003, ISBN: 0841237972

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