THE ROYAL SOCIETY OF CHEMISTRY

ENVIRONMENTAL CHEMISTRY GROUP

Newsletter

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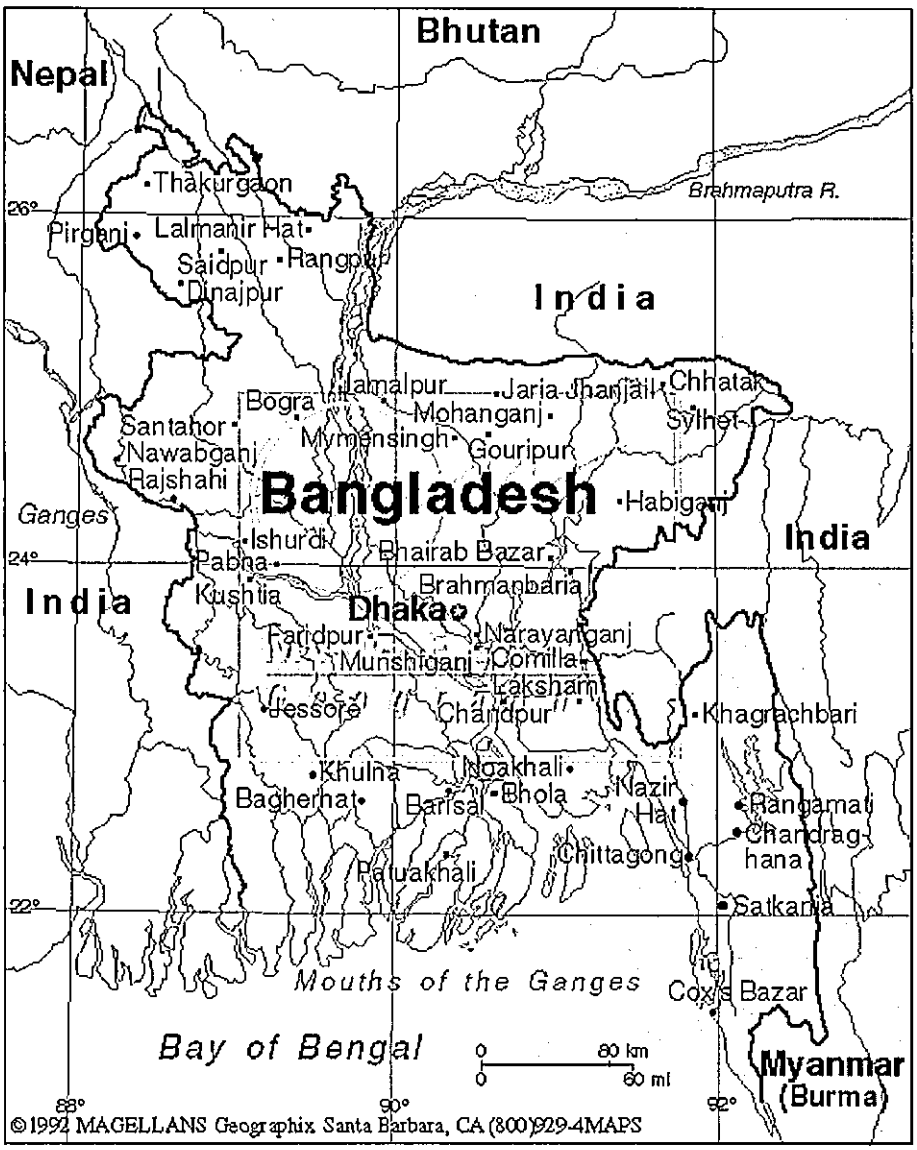

MAP OF BANGLADESH - reproduced with permission from the publisher, December 1998

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Chairman's Report on Activities during 1998

1998 has seen the publication by various Governmental Departments/Agencies of a large number of consultative documents concerned with environmental matters.

These include 'Opportunities for change - a revised UK strategy for sustainable development'; 'Control of chemicals in the environment - a strategy for the UK'; 'Sustainable production and the use of chemicals'; 'Climate change'; 'Endocrine disrupting substances in the environment - what should be done?'

The RSC replies to these documents *via* the Environmental Health and Safety Committee which contains representation from the Environmental Chemistry Group. It will be interesting to see whether this increased consultation actually leads to better practice in the control of the environmental impact of chemicals. The main concern must be to ensure that Government actions are based on realistic scientific information. The fate of chemicals in the environment, whether the chemicals are of natural or anthropogenic origin, is often an extremely complex problem to which there is no quick answer. The arsenic in Bangladesh 'story' that we have covered in some detail in this and the previous issue of the Newsletter illustrates the complicated interactions between environmental chemistry, hydrogeology, government policies, social activities and health effects.

Arsenic-Contaminated Groundwater in Bangladesh

In the June 1998 edition of this Newsletter, Michael Brooks described the crisis in Bangladesh where an estimated 77 million people are consuming water which contains levels of arsenic above the revised World Health Organisation standard (10 ppb) for As in water. Three more contributions on this serious health issue are included in this issue of the ECG Newsletter.

First we are grateful to Michael Brooks for an update on the situation in Bangladesh and a further review of techniques for removing arsenic from water. Secondly Joinal Aberdin, a PhD student from Aberdeen University, describes some of the social consequences of arsenic contamination and introduces us to his research work - the effects of arsenic-contaminated irrigation water on agriculture. And thirdly we reproduce a letter from *Nature* on the geology of the affected regions in Bangladesh and West Bengal and the geochemistry which causes release of As into groundwater.

Environmental Chemistry Group Distinguished Guest Lecture 1999

The group is extremely pleased to have the Nobel Laureate Professor Mario Molina talking about global climate change on 3rd March in the Royal Society's lecture theatre. We hope that as many of you as possible will come along to hear this world renowned figure (especially as the meeting is free to Group members). It is not often that we are able to attract such an important environmental chemist from the USA and we are grateful to the Angela and Tony Fish Bequest for sponsoring this meeting. The afternoon will be made even more informative by the contributions from Professor Peter Simmonds and Dr. David Fiske respectively on measuring changes in gas concentrations and on policy decisions for the control of ozone-depleting gases.

The Committee continues to be concerned about the difficulty in attracting sufficient numbers of people to meetings. I know that this is a trend common to most Groups in the Society. We are able to put together programmes that have leading experts in their fields of environmental chemistry. Generally the audience numbers mean that one has to question whether the time and effort spent by the speakers and the organisers is worthwhile. Should we no longer organise symposia? If you have any comments that you might like to make on the continuation of symposia, their topics, their venues or other activities I would be pleased to receive them.

Peter O'Neill
Chairman, December 1998

Drinking Water Contaminated by Arsenic in Bangladesh - an Update

Michael Brooks reports on recent developments in the arsenic-contaminated drinking water crisis in Bangladesh.

Since my original article, the drinking water crisis in Bangladesh has received further media attention and more information has been gathered on technologies for removing arsenic from water.

UK Publicity

An article in *The Independent* on 5th September 1998 (page 15) highlighted the problem:

". . . 2.5 million public and private handpump tubewells have been installed, bringing . . . drinking water to 97 per cent of the population."

"Already this year 18,000 new tubewells have been installed."

". . . . it appears that arsenic is present in the water supplies of 48,000 of Bangladesh's 68,000 villages in 21 out of the nation's 64 districts. The drinking water of 60 million people - half the population* - may be contaminated. Levels of contamination range from 50 parts per billion - five times the current maximum level recommended by the World Health Organisation - to 1000 parts per billion, 100 times the safety limit."

"They [UNICEF, who have actively promoted the use of tubewells over the last two decades] are not complacent, they are perhaps stunned" says Han Heijnen, environmental health adviser at the World Health Organisation in Dhaka. "Maybe 60 million people have been exposed to arsenic in the water. This causes two sorts of problems. One is the visible skin problems, which may be halted if arsenic

ceases to be ingested, even if they cannot be reversed. The other is where the problem has gone too far, resulting in cancer of the intestine, and which may, in four or five or ten years become an overwhelming health problem here, like Aids in Africa."

"While UNICEF is exploring (among other things) the idea of sinking much deeper tubewells, at much greater expense and technical difficulty, Mr Heijnen, like Dr Chakraborti over the border in Calcutta prefers something simpler: teaching villagers to harvest Bangladesh's abundant rainwater - guaranteed arsenic- free - in simple, cheap plastic tanks."

International Help

It was announced in Dhaka on September 21st 1998 that Bangladesh has signed an agreement with the International Development Agency, (part of the World Bank), for implementing an "Arsenic Mitigation Water Supply" project in the country. Under the agreement the World Bank will provide Bangladesh with 32.4 million dollars at a concessionary rate. The project will be carried out by the Department of Public Health Engineering and will facilitate on-site mitigation and improved understanding of the arsenic problem in the country.

The West Bengal & Bangladesh Arsenic Crisis Information Centre

The West Bengal & Bangladesh Arsenic Crisis Information Centre has provided a very comprehensive Website at http://bicn.com/acic/

Links to recent media coverage and other research groups may be found on this site.

Arsenic Removal Technologies

Here are some more processes for removing arsenic from water which were not included in my previous article.

1. Iron Filings Filter

Developed by the University of Connecticut, the filter consists of fine iron filings and sand. When inserted into the well water pipeline the iron corrodes and is claimed to take all the arsenic out of the water. The system, for which a patent has been applied, was developed from work undertaken at a contaminated landfill in central Maine, USA. Some landfills have arsenic problems stemming from unchecked disposal of chemicals containing arsenic such as herbicides.

Professor Nik P. Nikolaidis, leader of the development team says "I hope we will be able to create an inexpensive technology that can be used here in the USA and in countries like Bangladesh to save people's lives".

2. Photo-arsenic Removal

Developed and patented in Australia and currently under trial in Bangladesh, this is a light-assisted process to oxidise, remove and immobilise arsenic from groundwater and acid mine drainage. Added iron salt is used as both the photo-absorber and the subsequent co-precipitant for arsenic removal and immobilization. Alternatively, a soluble proprietary compound can be used as the photo-active agent. In late 1996 the process was successfully used to oxidise and remove arsenic from acid mine water draining from an abandoned gold mine in Montana, USA.

Laboratory tests showed that the sunlight-assisted process can be used to remove arsenic from simulated groundwater/ arsenic combinations to leave less than the WHO drinking water guideline of 10 ppb As. Shallow troughs can be used as the photo-reaction vessels. No aeration is needed when the dissolved arsenite concentration is low. Field trials will be performed to remove arsenic from tube-well water in Bangladesh in late 1998.

3. Membrane Distillation

HVR, a Swedish Company, are currently testing their membrane distillation technology at a contaminated well in West Bengal. "A new unit operation for processing of liquids. Hot contaminated water flows alongside a microporous, hydrophobic membrane. Surface tension prevents water, whilst in a liquid state, from penetrating the non-wettable membrane. Instead the water evaporates and, as vapour, passes through the pores of the membrane and condenses on the cooling surface." HVR test results demonstrate complete removal of both As III and AsV valence states from 10mg/ litre arsenic contaminated water.

4. Natural Charcoal

This material, marketed as Brimac 216 by Talo Products, is reported to have good adsorption characteristics for arsenic. Investigations have shown that the valency of the arsenical species is critical in that arsenious species are adsorbed whereas arsenicV species are not. Adsorption of arsenious species is better at higher pH levels. For more information on this technique, please contact Mike Knowles of Tate and Lyle Process Technology at 01475 720273.

5. Activated Alumina

Information on the selectivity and use of activated alumina for arsenic, fluoride, zinc, lead, chromium, phosphate and other contaminant from potable water is available from Dr Farid Azizian of Alcan Chemicals Limited who can be contacted at 01753 233 371.

Portable Field Instruments for Arsenic Analysis

There is an urgent need for robust, portable instruments to measure arsenic concentrations in the field to very low levels. With the WHO guideline revised from 50 ppb to 10 ppb, an instrument capable of detecting arsenic levels below this value, ideally down to 2 ppb, would be of enormous benefit to field workers.

Walter Kosmus from the University of Vienna (walter.kosmus@funigraz.ac.at) has developed an automated "Gutzeit" method which is based sequentially on arsine generation (with good gas control), colour development on filter paper, and automatic spectrophotometric detection - all in a single little head. Some other workers are reportedly developing electrochemical methods.

Fluoride in Drinking Water

It is not only arsenic in drinking water that is a problem in the Indian sub-continent. According to an article in *The Guardian* of July 9th 1998 very high levels of naturally occurring fluoride in drinking water have reportedly resulted in an estimated 60 million people leading

"a painful and crippled life" from fluorosis - six million of them children. In one village almost all the children are knock-kneed and exhibiting the brown-stained teeth characteristic of the first stages of fluoride poisoning. They drank water from a poisoned pump whilst attending the village primary school nearby. Fluoride levels were 11 times the safety limit of one part per million.

If you have any comments or suggestions please contact the writer at the address below.

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* In a letter to *The Independent* (16th September 1998), two workers from Unicef challenged the statement that half the population of Bangladesh is drinking from tubewells contaminated with arsenic. To date, one fifth of the 19,000 tubewells tested with Unicef's support have been found to be unsafe. Until tubewells from all parts of the country have been checked, the number of people affected will remain unclear. The Unicef workers also pointed out the benefits which had been gained in sanitation by providing clean water, free of faecal bacteria, from tubewells.

The Environmental Chemistry Group thanks Les Roland of the IChemE for permission to reproduce this article.

Arsenic-Contaminated Groundwater in Bangladesh

Joinal Abedin from Aberdeen University describes the background to his PhD project on arsenic mobility in contaminated soil.

About 97% of the 120 million Bangladeshi population use well water as a source of drinking water. Contamination of groundwater with arsenic and the consequent adverse effects on human health were first reported by Indian experts in the early 1980s in two locations near the Bangladesh border. Bangladeshi authorities became aware of the arsenic problem in ten districts in 1992.

According to a 1997 survey, jointly carried out by the Dhaka Community Hospital and the School of Environmental Studies (SOES) of Jadavpur University, Calcutta, an estimated 8,065 tube wells from 60 districts have been tested for the presence of arsenic in groundwater. In 41 districts half the water samples were found to have As levels above 0.05 mg/L, the maximum permissible limit previously set for As in water by the World Health Organisation (WHO). In 52 districts the As concentration was more than 0.01 mg/L, the revised standard for As in water recommended by the WHO.

The total area of the 41 districts is 89,186 sq. km, with a population of 76.9 million. The tube wells that were found to be arsenic-free, may not remain so because they may also become contaminated with time due to groundwater flow.

According to the Bangladeshi news agency, UNB, some 2,027 people have been identified as arsenic patients and about 65 million are at risk of contamination across the country. The chronic arsenic poisoning (arsenicosis) causes malonosis - a term used to describe soaring of skin surface and mucous membrane. The ultimate result is tissue mutation which may cause cancer, but not in all cases. In fact, arsenicosis starts long before it is actually visible on the skin. It affects other organs of the body before finally appearing on the skin. Another problem which has further aggravated the situation is that until recently there was no specific treatment for arsenicosis other than advising patients to stop drinking arsenic-contaminated water.

Arsenicosis is also creating some social problems. It is difficult to arrange a marriage for young girls affected by arsenic. Sometimes affected housewives are divorced by their husbands. In fear of social exclusion, some affected people hesitate to admit their affliction, which ultimately may further harm their health.

Generally, the normal irrigated soil of Bangladesh contains 4-8 mg As per kilogram soil, while areas where irrigation is performed with the arsenic-contaminated water have increased arsenic concentrations up to 83 mg per kilogram soil. The presence of high concentrations of As in soil and the use of irrigation water with high As concentrations may also increase the As content in cereals, vegetables and other agricultural products of the As affected areas. In Bangladesh, about 80 % of the cultivable lands are covered by rice and huge amount of underground water is needed to cultivate this crop, especially in the dry season. Because rice is the staple food of this area and rice straw is used as cattle food, it has become necessary to evaluate the impact of using arsenic-containing irrigation water on the levels of arsenic in rice grain and straw. There are reports that phosphate fertilisers increased the downward movement of arsenic in the arsenic-contaminated soil.

Therefore, experiments are being conducted at Aberdeen University to study the effects of arsenic-containing irrigation water and phosphatic fertiliser on the available arsenic content in soil and total arsenic content in rice plants.

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Arsenic Poisoning of Bangladesh Groundwater

In Bangladesh and West Bengal, alluvial Ganges aquifers used for public water supply are polluted with naturally-occurring arsenic; which adversely affects the health of millions of people. Here we show that the arsenic derives from reductive dissolution of arsenic-rich iron oxyhydroxides which in turn are derived from weathering of base-metal sulphides. This finding means that it should be possible, by sedimentological study of the Ganges alluvial sediments, to guide the placement of new water wells so that they will be less polluted with arsenic.

As many as a million water wells Bangladesh and West Bengal, drilled into Ganges alluvial deposits, may be contaminated with arsenic[1-6]. Measured concentrations[1-6] range up to 1000 μg/l, which is above the limits set for Bangladesh drinking water (50 μg/l) or recommended by the World Health Organisation (10 μg/l). Consumption of this water has lead to widespread death and disease[1-6].

Arsenic has been reported to derive from the oxidation of arsenic-rich pyrite in the aquifer sediments as atmospheric oxygen invades the aquifer in response to a lowering of the water level by abstraction[4,5]. This explanation is not consistent with the following observations[3], made on 46 wells, typical of those in Bangladesh, that were sampled during May and June, 1997: in oxic (shallow) wells, arsenic concentrations are mostly below 50 μg/l; in anoxic waters, arsenic concentrations (≤260 μg/l) correlate with concentrations of dissolved iron (≤29 mg/l) and bi-carbonate; arsenic concentrations increase with depth in wells at Manikganj, Faridpur, and Tungipara. These observations suggest that arsenic is released when arseniferous iron-oxyhydroxides are reduced in anoxic groundwater[6], a process that solubilises iron, and its absorbed load, and increases bicarbonate concentrations. Sedimentary iron oxyhydroxides are known to scavenge arsenic[7] and, in aquifer sediments, concentrations of diagenetically-available iron (≤3.7%) and arsenic (≤26 ppm) correlate well[3].

The arsenic-rich groundwater is mostly restricted to the alluvial aquifers of the Ganges delta[3,6], so the source of arsenic-rich iron oxyhydroxides must lie in the Ganges source region upstream of Bangladesh. Weathered base-metal deposits occur[6,8,9,10] in the Ganges basin (Bihar, Uttar Pradesh, West Bengal), so weathering of these arsenic-rich base-metal sulphides must have supplied arsenic-rich iron oxyhydroxide to downstream Ganges sediments during Late Pleistocene-Recent times. The arsenic-rich iron oxyhydroxides are now being reduced, causing the present problem. Reduction is driven by concentrations of sedimentary organic matter[3] of up to 6%.

A knowledge of the sedimentary architecture and distribution of iron, arsenic and reductant carbon in Ganges alluvial sediments will enable a predictive model to be developed to guide future aquifer development in a way that minimises arsenic pollution. Furthermore, on oxidation dissolved iron precipitates as iron oxyhydroxide, which scavenges arsenic from solution. It follows that simple aeration of anoxic Bangladesh groundwaters, followed by settling, should remove a considerable amount of arsenic from solution. This simple treatment can be performed at a household scale. Whilst the disposal of the arsenic-rich iron oxyhydroxides would require special arrangement, this would be preferable both to the widespread poisoning that now exists and to a return to the use of contaminated surface water for public consumption.

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Environmental Law Focus No.2

In the second of his reviews of environmental law, Anthony Hobley of Cameron McKenna reports on developments during 1998.

This last year has seen much activity in environmental legislation and policy, both from the British Government and the European Union. As is to be expected in this area, some changes are technical, for example updating the classification, packaging and labelling of dangerous substances in the light of technical progress, whereas others are bringing in new forms of regulation, extending the law to new areas of business, and giving rise to additional civil and criminal liabilities. A number of the more far reaching developments are explained in more detail in this review.

Implementation of the IPPC Directive

A bill to implement the **Integrated Pollution Prevention and Control (IPPC) Directive** was introduced in the House of Lords at the end of November 1998. **The Pollution Prevention and Control (PPC) Bill** makes provision for regulations to be made establishing a new pollution control system covering installations subject to the Directive plus processes currently regulated under the Integrated Pollution Control (IPC) and Local Authority Air Pollution Control (LAAPC) systems under Part I of the Environmental Protection Act 1990. The government intends to repeal Part I of the 1990 Act and replace it with a single coherent system of regulation.

As discussed in the first *Environmental Law Focus* (ECG Newsletter Issue No. 7, January 1998), whereas the IPC system regulates "processes", the IPPC Directive applies to "installations", which means the scope of regulatory control will be widened to cover some installations which are not presently covered under IPC.

In the Explanatory Notes which go with the Bill, the Government estimates that an additional 2,600 installations will need to be regulated by permits. Equally, the range of environmental issues considered in the regulatory control process will be extended to include issues such as energy efficiency, contaminated land, noise, vibrations, consumption of raw materials, waste minimisation and accident prevention.

The PPC Bill is a framework bill, as is increasingly common with environmental legislation in the UK. This means that much of the detail is to be provided in regulations to be made by the Secretary of State. It is envisaged that this power, as far as it relates to Scotland and Wales, will be transferred to the Scottish Executive and the National Assembly for Wales respectively.

The Bill itself provides little in the way of concrete requirements although it does give the Secretary of State the power to set and allocate quotas for emissions and to set up schemes to trade such quotas. In addition, it empowers the Secretary of State to import a couple of requirements which currently exist in English law only in Part II of the 1990 Act, which deals with waste. One is the provision requiring permit holders to be "fit and proper persons", which in the waste management licensing system covers technical competence and financial provisions to ensure the applicant can discharge its obligations under the licence, and requires that the applicant must not have committed certain environmental offences. The other relates to the imposition of clean-up requirements in connection with the surrender of a permit. Although the Explanatory Notes say that the former is so that the fit and proper person requirement will still apply to those waste management installations that cease to be licensed under Part II and instead are entirely regulated by the PPC system, the latter is a specific feature of the IPPC Directive which provides that, after activities at the installation have ceased, the site must be returned to a satisfactory state.

The Government is intending to publish the regulations in draft along with the third consultation paper by the end of 1998. Time is short as the Directive itself requires that it must be implemented into national legislation and brought into force in national law by 31 October 1999. From this time, new installations will require an IPPC permit. Existing installations have until 2007 before they must comply.

Groundwater Protection

From 1 April 1999 the new **Groundwater Regulations** will require disposals of certain substances!zo land to be authorised. The Regulations complete the implementation of the Groundwater Directive, following the European Commission's threat to take the UK to the European Court of Justice over its failure to implement the Directive properly. Consequently the Regulations slot into existing English water pollution legislation rather than repealing any existing laws - they do not, for example, apply where a waste management licence is in force since the Directive has already been implemented in respect of waste management licensing.

One of the main areas which will come under regulation for the first time is the spreading of used sheep dip. This was one of the Commission's concerns, and the Environment Agency reported in the autumn that there has been a substantial increase in the number of sheep dip pollution incidents.

The Regulations cover the direct or indirect discharge to groundwater of substances categorised as list I or list II. These lists are used throughout EU water pollution legislation and are also known as the 'black list' and the 'grey list'. The lists are set out in the schedule to the regulations, and list I substances include organohalogen and organophosphorus compounds, mercury and cadmium, plus substances with carcinogenic, mutagenic or teratogenic properties in water.

The Regulations impose an absolute ban on direct or indirect discharges of list I substances, including by tipping. Authorisation for any activity in or on the ground which might lead to an indirect discharge can be granted after an investigation of the local hydrogeology, soil conditions and risk to the groundwater, and subject to technical conditions to prevent any discharge.

List II substances are subject to a more risk-based approach - both in their

two-prong definition as substances which are in one of the listed groups and "could have a harmful effect on groundwater", and in the way in which authorisations are granted. Direct and indirect discharges can be authorised provided they are subjected to prior investigation, and the conditions of the authorisation are concerned to prevent pollution - *i.e.* a discharge causing harm - rather than a discharge *per se.*

In addition to its powers of authorisation, the Environment Agency will also be able to serve notices prohibiting activities which are being carried on or are about to be carried on which might lead to an indirect discharge of a list I substance or an indirect discharge leading to pollution of a list II substance.

Dangerous Substances and Preparations

The European Commission has adopted a report on EU chemicals legislation with a view to amending and streamlining the legislative framework and placing greater emphasis on the precautionary principle. EU directives currently govern the classification, packaging and labelling of dangerous substances and dangerous preparations, the evaluation and control of the risks of existing substances and the marketing and use of dangerous substances.

The report is a response to public concern about the circulation of chemicals in the internal market and also due to the need for the provisions to be able to deal with emerging problems such as endocrine disrupters. In particular, the report highlights the need for the legislation to be implemented and enforced more rigorously and consistently.

Meanwhile, there is a proposal already in existence for a Directive on the classification, packaging and labelling of dangerous preparations. This Directive would replace and consolidate existing legislation concerning dangerous preparations, pesticides and child resistant fastenings for containers holding dangerous materials. In addition it would require the environmental hazards of dangerous preparations to be classified and labelled for the first time. This has been a requirement for dangerous substances for several years.

Insolvency and Environmental Law

1998 saw an interesting test of the strength of environmental law and the public interest of environmental protection. The case, *Re Mineral Resources; Environment Agency v Stout,* in the High Court in April 1998, was about the interaction between insolvency law and the waste management licensing laws. A company with a valid waste management licence went into liquidation and the liquidator tried to disclaim the licence. Ordinarily, an insolvent company's interests in such things as leases, contracts and licences can be disclaimed by the liquidator under the Insolvency Act 1986 to enable a smooth and swift liquidation, but the Environmental Protection Act 1990 (EPA) provides that waste licences cannot be surrendered unless the Environment Agency accepts that surrender, which it can only do if it is satisfied that the land has been left in a satisfactory condition.

The court held that the EPA should over-ride the Insolvency Act so that the licence could not be disclaimed. Much of the decision rested on the principle that later statutes over-ride earlier ones, but the judge also considered the public interest involved in protecting the environment. It remains to be seen what the consequences of this will be for, say, landfill operators who go bust, although in the longer term the draft landfill directive (discussed in the last update) intends to ensure, as a condition of granting a waste management licence, that financial security is already in place to cover such a situation.

Contaminated Land Update

In the previous *Environmental Law Focus* we talked about the new **Contaminated Land Regime** which will address historic contamination of land. Although it is still not in force, it looks as though the wait is coming to an end. The Department of Environment, Transport and the Regions (DETR) announced in a press release in July 1998 that the Government intends to bring the Contaminated Land Regime into force by July 1999. It also announced that the Government was to make available to local authorities an extra £50 million of funding over three years to support the implementation of the Contaminated Land Regime.

Although the DETR says that it is still on course for implementation by July 1999, the statutory guidance has yet to be finalised. It is not possible to determine the full impact the Contaminated Land Regime will have until the Statutory Guidance has been finalised and the regime is finally in force. The draft Statutory Guidance for the Contaminated Land Regime requires local authorities to "prepare, adopt, publish and implement a formal written strategy for the inspection of its area". Such policies are required to be published within 15 months of the **Contaminated Land Regime** coming into force but as each local authority is responsible for its own strategy and implementation, enforcement of the Contaminated Land Regime may not always be consistent.

The **Contaminated Land Regime** will be relevant to contaminated land where there is an ongoing use of that land, but where the land is to be redeveloped the contamination will continue to be dealt with under the planning system. In order to harmonise these two systems, the DETR is updating its planning guidance, Planning Policy Guidance 23, to bring it into line with the risk assessment approach taken by the Contaminated Land Regime.

Further developments will be addressed in the next *Environmental Law Focus.* Inevitably, this update cannot go into all the intricacies of the new laws it discusses and cannot cover anything but a handful of the developments over the last twelve months. Further details on the above matters or any other environmental law issue are available from the author.

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December 1998

Environmental Chemistry in South West England (1)

Marine Chemistry and Organic Geochemistry at the University of Plymouth

One of the major international environmental issues concerns the sustainability of the marine environment against ever increasing pressure from mankind. Anthropogenic activities contaminate seawater and sediments and in turn the marine food web is affected.

Marine chemists at the University of Plymouth are playing a major role in researching, and sometimes solving, these problems by applying multi-disciplinary approaches, involving chemists, biologists, physicists and numerical modellers. Their research activities are described by Professor Geoffrey Millward.

Analysis of Seawater

Crucial to these investigations is the identification and quantification of chemical processes taking place at interfaces, including air-sea interactions, river water-seawater mixing, and sediment-water exchange, together with investigations of uptake of metals by phytoplankton and heterogeneous chemical reactions at particle surfaces.

Many of the chemical processes are dependent on seawater conditions such as salinity, temperature, pH, oxygen tension and the concentrations and types of particles in the water column, including phytoplankton and bacteria. These factors determine the distributions of nutrients (NO_3^-; NO_2^-; NH_4^+; PO_4^{3-}; Si), trace metals and organic micropollutants in the dissolved and particulate forms. Chemical analyses of dissolved and particulate constituents and their speciation form the foundation of the subject (Millward, 1995). Consequently, there is considerable effort devoted to the design and application of new measurement techniques.

Seawater is a difficult matrix in which to determine trace constituents directly because samples need to be filtered to remove suspended particles and the salt concentration interferes with analyses. However, marine chemists in Plymouth have turned their attention to ways in which direct determination may be achieved, by-passing the need for sample collection and pre-treatment, thereby reducing the potential for sample contamination and increasing the measurement frequency.

Ship-board Determinations

Ship-board determinations of dissolved nutrients are commonplace at Plymouth and an autonomous continuous *in situ* nitrate monitor for use in estuaries and coastal waters has been designed and built by the University in collaboration with the Plymouth Marine Laboratory (PML) (David *et al.*, 1998). The collaboration has also resulted in the development of a method for the determination of dissolved Fe in seawater by flow injection, with chemiluminescence detection (Bowie *et al.*, 1998).

Trace Metal Analysis

A new state-of-the-art approach to shipboard and *in situ* determinations of dissolved trace metals has been tested in the Mediterranean Sea (Achterberg and van den Berg, 1997) and in Liverpool Bay (Achterberg and van den Berg, 1996), and is now being exploited in contaminated mine streams in southern Spain. The voltammetric methods have considerable scope for further development, especially in improving our knowledge of dissolved trace metal speciation in marine waters and rainwater samples (Nimmo and Fones, 1996).

The trace metals often have a dual biological function dependent on their species. Many organically complexed trace metal species are biologically unavailable, whereas the inorganic species are available, as is the case for the impact of dissolved Cu species on marine algae (Gledhill *et al.*, 1997). The voltammetric techniques are also now being applied to laboratory studies of the kinetics of heterogeneous chemical reactivity of trace metals.

Organic Micropollutants

However, the direct determination of organic micropollutants is often impossible, mainly because of the low concentrations and the difficulties of distinguishing the huge array of potential congeners. For example, polychlorinated biphenyls are found at concentrations of ng/g and dioxins are three orders of magnitude lower. Thus, considerable pre-treatment of seawater and sediment samples is required to remove natural organic material, prior to their detection and quantification in gas-chromatography-mass spectrometry (GC-MS) or liquid-liquid chromatography-mass spectrometry (LC-MS).

During the NERC Land-Ocean Interaction Study, organic geochemists at the University and PML were responsible for producing the first axial distributions of herbicides (atrazine), pesticides (malathion, lindane) and PAHs (fluoranthene, pyrene) in the Humber Estuary and its plume (Zhou *et al.*, 1998). These advanced techniques used to determine these compounds are now being targeted on the problems of evaluating the fate of Produced Water discharges from oil platforms in the North Sea.

Estuarine and Coastal Environmental Models

Managers of estuarine and coastal environments require computer-based models to aid them with their decision-making. The marine chemist not only provides fundamental quantitative information on the processes involved but also provides the essential data on temporal and spatial variabilities of the constituent concentrations, which are essential to model validation. The Department is working in close collaboration with modellers at PML, where the flexible software package called the Estuarine Contaminant Simulator (ECoS) has been developed. This allows any estuary to be modelled with basic hydrodynamics upon which the chemistry and biology may be superimposed.

Process-oriented studies focusing on particle-water interactions, use radiochemical techniques to evaluate the kinetics and equilibria of adsorption and desorption reactions (Turner, 1996). Collaborative research between the Department of Environmental Sciences and PML has produced an ECoS model of Tamar Estuary which simulates the behaviour of dissolved Ni and Zn (Liu *et al.*, 1998). Models predicting trace metal dispersion in the Humber and Tweed estuaries are now under development as part of the NERC LOIS Project. Coupled hydrodynamic-chemistry models of this type are at the cutting edge of research and there is the expectation that, ultimately, they will be adapted for user-friendly desk-top application by managers.

The Sea as a Source of Chemicals

Of course, as well as acting as a recipient of Man's chemicals the sea is also a major producer of natural chemicals (or strictly speaking the algae of the sea are major primary producers). Our research at Plymouth has involved a detailed study of some of the products of diatomaceous algae for many years (*e.g.* Robson and Rowland 1986; Wraige *et al.*, 1998). These compounds are 'chemicals fossils' of diatom inputs to sediments (*e.g.* Cooke *et al.*, 1998) and our recent studies suggest that the changes in distributions of the alkenes may reflect the growth temperatures of the algae, and therefore may be useful as proxy measures of past temperatures. An exciting and unexpected finding is that a number of the individual chemicals which we have identified fully by NMR spectroscopy, exhibit cytostatic properties to a drug-resistant form of human lung cancer when tested in vitro (Rowland, 1998).

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Environmental Chemistry in South West England (2)

Environmental Foresight: The Science Needed to Create a Sustainable Future

Professor David Taylor, Environmental Foresight Group Manager at Zeneca's Brixham Environmental Laboratory, charts the development of this site since its inception half-a-century ago and explains how the Laboratory's Environmental Foresight programme is helping to promote the ideas behind the concept of Sustainable Development.

Introduction

Sustainable Development, was summarised in the Brundtland Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This concept is very easy to define but very difficult to put into effect. The three pillars on which sustainable development is built are economic growth, environmental improvement and social enhancement. Sustainable solutions to current problems are those where all three of these pillars overlap. Sustained effort will be needed in all three of these areas if we are to create a sustainable future. The Brixham Environmental Laboratory has long been associated with combining environmental improvement with economic growth and in recent years, *via* its environmental foresight programme the Laboratory has been providing insights into a more sustainable future.

Historical Perspective

In 1998, the Brixham Environmental Laboratory celebrates 50 years of achievement in environmental research. Originally established by ICI as a field station to explore the environmental impact of anti-fouling paints, the Laboratory, now part of Zeneca Limited, has become a leading industrial environmental science facility with a world-wide reputation for the excellence of it's science amongst governments, regulatory agencies, non-governmental organisations and academics.

In 1948, the small team of biologists at Brixham, were concerned with investigating the life cycle of the common fouling organisms, such as algae and barnacles. This helped in the design of more effective and targeted anti-fouling systems, with greater efficacy but lower environmental impact than the products that they replaced In the 1950's, nearly 40 years before the implementation of the EU Environmental Impact Assessment Directive, the Laboratory became involved in extensive environmental impact investigations for new chemical plants, both in the United Kingdom and overseas.

Subsequently staff at the Laboratory became involved in the design of industrial effluent treatment plants, and Brixham staff hold patents on some of the initial high rate biotreatment systems. In the 1970's and 80's the Laboratory continued to develop and extend its skills in environmental impact studies particularly in the fundamental understanding of ecotoxicological and biodegradation processes, and also extended it's interests into the atmospheric and terrestrial environments.

The Laboratory Today

The Laboratory is still located on its original site at Freshwater Quarry on the edge of the English Channel in Brixham. It has over 100 staff, most of whom are graduate and postgraduate scientists whose skills range across a wide spectrum from analytical science to zoology.

The Laboratory provides a comprehensive multidisciplinary approach to the investigation and resolution of environmental issues and has extensive, GLP compliant, laboratory facilities for the investigation of all aspects of environmental fate and effects, in both air, surface and groundwater, and soils and sediments. It has a widely experienced, and well equipped, field investigation team which can be deployed on a world wide basis. The Laboratory employs its state of the art analytical capability, both to support it's experimental facilities and to undertake field monitoring. In addition, the Brixham Laboratory uses advanced computer technology for environmental modelling and has extensive capabilities in information management.

Current development projects involve the application of molecular diagnostic techniques to environmental problems, the deployment of biosensor systems for monitoring the environmental impact of waste streams, the application of Toxicity Identification (TIE) protocols to develop effluent improvement plans, the use of mathematical models in environmental risk assessment, and the development and application of improved methods for the generation, and dissemination of regulatory information.

Environmental Foresight

Any business that wishes to survive into the future must pay attention to changing societal demands and to do this efficiently requires early warning of likely changes. The primary objective of Environmental Foresight activity is to provide clients with advance warning of environmental and regulatory pressures and to provide help and assistance to them to either avoid or overcome these obstacles. The current programme is designed to fulfil three separate functions by providing:

- early warning of new regulatory initiatives and their potential implications for the businesses;
- a mechanism to influence the quality and scientific validity of new regulatory initiatives including primary legislation, subsequent regulations and their implementation;
- advice on the interpretation of existing regulations.

The information gleaned from this activity then drives a major research effort. The Laboratory is involved in environmental research in four major areas. In addition the Laboratory is working in partnership with a number of universities both in the United Kingdom and overseas to explore new areas of environmental research.

The four major research programmes are:

(i) The Environmental Impact of Endocrine Disrupting Substances

The laboratory was already working in this area, before it achieved its current high profile, and is now one of the leading industrial laboratories in the world in this area. The programme is being developed with a number of collaborators including the UK Environment Agency, the US EPA, the Wellcome Trust, Brunel University and the Endocrine Modulators Steering Group (EMSG) of the European Chemical Industry Association (CEFIC).

(ii) Ecosystem Dynamics

In order to reduce the level of uncertainty in risk assessment we need to gain a better understanding of persistence and bioavailability. These are two areas of environmental science where fundamental studies still need to be undertaken and the Laboratory's research into Ecosystem Dynamics is intended to fill in some of the gaps. This programme is also related to studies being undertaken into the link between laboratory generated data and field experience.

(iii) The Optimisation of Biological Treatment Technology

Although biological treatment plants have been being built and used to treat industrial effluents since Victorian times, almost nothing is known about the underlying microbiology. The objective of this programme is to understand how to optimise plants to deal efficiently with more industrial effluents, using less pre-treatment. Experimental microbiology, molecular diagnostics and subsequent engineering skills are being marshalled onto such problems as recalcitrant ('hard') COD, nitrification inhibition and the treatment of high/low pH wastes with high dissolved solid content.

(iv) The Development of Biomonitoring Systems

The use of biological measurement techniques to determine the environmental impact of waste streams entering the environment has many advantages, although there are also some considerable difficulties and drawbacks. The research programme has been aimed at looking at new technology such as biosensors, together with efforts to miniaturise and automate existing test systems so that they can operate on the small sample volumes that are typically generated in a TIE study. Considerable success has already been achieved in this programme and the results are being fed into the DTA Demonstration Programme currently being run jointly by the Environment Agency, SNIFFER, UKWIR, the Dti and the Environet Foundation.

The output from the research programme is of great value to the clients, however staff are also encouraged to publish the results of their studies in peer reviewed journals.

Sheridan Park Environmental Laboratory

A satellite laboratory at Sheridan Park in Toronto, Canada, is developing bioremediation technology for contaminated soil, sediment and groundwater. Staff at Sheridan Park have recently been awarded patents on a new technology called Xenorem™ for the bioremediation of chlorinated insecticides such as DDT, Lindane and Toxaphene in contaminated soil. A successful pilot study has now been completed in which a sample of 4000 tonnes of soil were cleaned to the level required in a period of 4-6 weeks. A major research effort is now being devoted to the extension of the Xenorem™ technology to deal with chlorinated aromatic materials such as PCBs, explosives and heavy metals.

The Environet Foundation

In 1998 the Laboratory agreed to provide operational support for the newly created Environet Foundation, a research funding body established by the chemical, agrochemical and pharmaceutical industries to make use of Landfill Tax rebates. The Environet Foundation can facilitate the transfer of landfill tax rebates from a landfill taxpayer into research effort on waste management. If anyone currently paying landfill tax is not using this opportunity because they are unsure of how this can be done, please get in touch and we will do our best to assist.

More information on the facilities and services offered by the Brixham Environmental Laboratory can be obtained from **Keith Moore** at 01803 882882 or on the Laboratory Website at http://www.zeneca.com/brixham/

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David Taylor
November 1998

The American Chemical Society's Division of Environmental Chemistry

This is the first of a series of contributions aimed at providing members with information on other associations similar to our own Environmental Chemistry Group.

The American Chemical Society has 155,000 members and contains 34 Divisions including one for Environmental Chemistry. The Division of Environmental Chemistry has about 5,000 members, publishes a Newsletter called EnvirofACS and has two web sites: (i) a site with information on symposia which the Division is helping to organise, plus news of other symposia of interest; this site is at http://gemini.tntech.edu/~mjw5030/acspage.html, and (ii) a general information site which also includes extracts from the Newsletter at http://www.acs-envchem.duq.edu/.

The symposia are generally held in association with the American Chemical Society's twice yearly main meetings The most recent was at at Boston on 23-27 August 1998, and in 1999 divisional symposia are planned at Anaheim, CA on 21-25 March 1999 and at New Orleans on 22-26 August 1999. The Boston meeting had symposia on the Environmental Impact of Fossil Fuel Utilisation; Advances in the Analysis of Environmental Endocrine Disruptors; Intentional Environmental Tracers; Humic Substance Mediated Environmental Reactions; Research and Educational Challenges in Environmental Chemistry. The Division also co-sponsors the Green Chemistry Symposia.

The Division has been investigating whether to move to electronic delivery of the abstracts from these symposia and of the Newsletter. Unlike ourselves, full abstracts are produced for all papers given in symposia and then circulated to

members of the Division. However, whereas our symposia only consist of invited speakers, theirs consist mainly of papers submitted by delegates. The selection for conference presentation is based on the submitted papers, plus abstracts. Hence the easy availability of the abstracts. The cost of printing and circulation is high, there is therefore pressure for them to move to electronic delivery. In a survey of their members they found that, though 90% had access to the web, 60% said they would prefer to receive a hard copy of the Newsletter and 40% would prefer a hard copy of the full abstracts. As with ourselves, their members found the Newsletter to be important.

The ACS is planning on setting up a certification programme for Environmental Analytical Chemists and Technicians. It is being suggested that applicants will have to sit an examination to become registered, plus an annual examination to enable them to have their certificate renewed. Approximate cost about 150 US dollars per year.

We are hoping to forge closer links with the Division of Environmental Chemistry and I will keep you up-dated on the progress we make.

Peter O'Neill

The RSC's Scientific Forward Look and the UK Foresight Programme - Recent Developments

The RSC's Scientific Forward Look

In 1997 the RSC started to develop a Scientific Forward Look for Chemistry which was intended to complement the government's Foresight Programme and to ensure that chemistry was not overlooked in future plans and funding for the UK science base. The Society's Forward Look is primarily science-led and aims to highlight the most exciting areas of chemistry and to show how these might lead to wealth creation and improved quality of life in the future.

A year ago the Society asked its subject groups and sectors to contribute their views on the Forward Look. The replies of the Environmental Chemistry Group and the Occupational and Environmental Toxicology Group appeared in issues 6 and 7 respectively of this Newsletter.

Now all the reports from the subject groups have been collated by RSC staff and summarised in six different papers representing the views of five of the Society's Divisions and of the interdivisional groups which report to the Scientific Affairs Board (including the ECG). These six papers are readily accessible from the Society's homepage on the Web at http://www.rsc.org

Apart from their intended use in the Foresight Programme, the responses provide a compelling account of the role, benefits and future directions of chemistry at the end of the 20th century.

The RSC invited comments on the summaries (consultations finished in November 1998) and the complete Scientific Forward Look will be used by the Society in the next round of the Foresight Programme which starts in April 1999.

UK Foresight Programme

Announcing plans in December 1998 for the next round of the Foresight Programme, Peter Mandelson, who was at the time the Secretary of State for Trade and Industry, explained the role of Foresight: "The Government's vision is to put the future on Britain's side. We want to see a revolution in the UK's competitiveness and our quality of life. Foresight is central to that objective. It brings together business, the science base, Government and the voluntary sector to look at the opportunities and challenges that lie ahead, helping us to identify those areas where we must act now if we are to reap the rewards of tomorrow."

The next round will have a broader focus than before. The work will be taken forward by ten sectorial panels covering key economic areas, and three thematic panels. Associate programmes will be run by professional institutions and other organisations, working closely with the Office of Science and Technology.

The panels will start work in April 1999; initial conclusions are likely by late 1999, and the final reports will be published in November 2000, to be followed by an "overarching" report from the Foresight Steering Group.

The ten sectorial panels for the next round of Foresight are: Built Environment and Transport; Chemicals; Defence, Aerospace and Systems; Energy and Natural Environment; Financial Services; Food Chain and Crops for Industry; Healthcare; Information, Communications and Media; Materials; Retail and Consumer Services.

The three thematic panels are: Ageing Population; Crime Prevention; Manufacturing 2020. Underpinning themes are Education; Skills and Training; and Sustainable Development.

Some financial incentives have also been announced in connection with the Foresight Programme. These include:

- the 90 million Foresight Challenge Initiative;
- new round of Foresight LINK Awards to support high quality research partnerships in Foresight priority areas between business and universities;
- opportunities for smaller firms to take a long-term view, for example through the SMART Foresight Awards and Foresight guides for small firms.

This funding is part of a separate but related government initiative to link UK industry more effectively with the science and technology knowledge base and announced in a White Paper 'Our Competitive Future: Building the Knowledge- Driven Economy', The Stationery Office, London, 1998.

An information pack on the Foresight LINK Awards - 'Guide for Applicants' - is available from: Foresight LINK Awards, LINK Directorate, OST/DTI, UG.B.32, 1 Victoria Street, London SW1H 0ET.

Information about current Foresight activities including details about the 1998 LINK Awards may be seen on the Website http://www.foresight.gov.uk

Sustainable Development

Submissions by the RSC's Environment, Health and Safety Committee to DETR Consultations on Aspects of Sustainable Development

Bob Hazell, Secretary of the Environment, Health and Safety Committee, reports on work by the Committee during 1998 in response to the UK Government's initiatives on sustainable development.

As I mentioned in the last issue of the ECG Newsletter (June 1998), one of the main activities of the Society's Environment, Health and Safety Committee (EHSC) is to respond to consultation exercises initiated by government departments, Royal Commissions and other organisations.

1998 was a particularly busy year for consultations (the EHSC made submissions on over sixteen). The Committee could have responded to many others but thought hard so as to limit itself to those consultations of most relevance to chemists and chemistry, and where the Society could make most impact.

An interesting development has been the tendency for government departments to consult earlier in the pre-legislative stage. Recent consultation documents have invited views on general issues rather than on specific, well-defined proposals. There are arguments for and against this trend but it does ask more of those who respond.

Among other consultations in 1998, the EHSC responded to four from the Department of Environment, Transport and the Regions (DETR) on aspects of sustainable development.

The UK was one of the first countries to prepare a national sustainable development strategy and this was published in 1994 following the United Nations Conference on Environment and Development at Rio de Janeiro in 1992. The present government is currently reviewing this strategy, and the four DETR consultation papers which form part of this review are:

- Opportunities for Change - a Revised UK Strategy for Sustainable Development;
- Sustainable Production and Use of Chemicals;
- Less Waste, More Value - the Waste Strategy for England and Wales;
- Sustainable Business - Sustainable Development and Business in the UK.

Each of these papers has important implications for chemists and chemistry. In its responses the RSC made the point that sustainable development has become the aspirational target of modern society in both developed, developing and underdeveloped nations. However, although the target is clear, the means to attain it are not. Nevertheless, chemistry and chemists will play an essential and major part in the transformations that are necessary to achieve a sustainable society. We warned the DETR not to fall into the trap of dealing with sustainable development in a compartmentalised manner. One of the major challenges is to ensure that a holistic approach is maintained to sustainability. Without this it is likely that truly sustainable solutions will be overlooked or that actions taken in isolation may lead to perverse responses.

The main points that the EHSC (on behalf of the Society) made on each of the four consultation papers are summarised below.

Opportunities for Change - a Revised UK Strategy for Sustainable Development

This consultation paper aims to set the framework for consideration of policies in other areas. It seeks to identify the major themes thought to underlie sustainable development.

The Society emphasised that chemistry is central in both understanding the environment and in ensuring that man's impact upon it is sustainable. We felt the thinking behind the consultation document was rather insular and did not take account of actions, for example, at the UN and EU level.

We also felt the DETR had failed to recognise that ultimately sustainability is impossible with continuing population growth. Indeed the goals set out in the consultation document might not be sustainable at a global level, even in the short to medium term, at current population levels. We proposed that the Government should provide a framework that would encourage financial and other incentives to innovate towards sustainability. However, this needs to be done with great care. Innovation is the key to a sustainable future and the Government must not inhibit innovation, but rather seek to channel it in an appropriate direction.

Attitude is a key factor in relation to sustainability but it is often overlooked. The Society suggested that active steps are required to change attitudes and values among the public, decision makers and others so that they embrace sustainability. We therefore applauded the DETR for establishing its Sustainable Development Education Panel.

RSC members will be aware of the Society's new Green Chemistry Network (*Chem. Brit.*, October 1998 (10), **34**, 43-45) which aims to promote education and the practice of sustainable chemistry. Our submission also reminded the DETR of this initiative and we offered to discuss the possibility of integrating RSC activities with government policy initiatives in this area.

Sustainable Production and Use of Chemicals

In his Foreword to this consultation paper Michael Meacher (the UK Government Environment Minister at the DETR) writes "... increasingly I hear concerns about the possible effects of chemicals on human health and the environment. In response to these concerns the Government has decided to review its chemicals policy, to identify areas where the legislation is weak, and to propose ways of improving or supplementing it."

The main thrust of the Society's response was to question why changes were thought to be necessary. As indicated in Mr Meacher's Foreword, the driving force for change seems to be the need to change public perception of risk rather than to express a real concern about sustainability or inadequate risk assessment.

It seems fundamental that the degree of effort needed to address this issue, and the type of response that should be made, depend critically on whether the threats are real or are manifestations of perception.

Indeed in general the consultation paper appears to take the threat from chemicals as fact and suggests measures to reduce this threat. The Society was very concerned about this, and suggested much more attention should be given to understanding the public's worries, something that the RSC itself is examining.

The Society was also concerned that the document actually helped to promote 'chemophobia' both in its tone and in its misleading use of statistics. Indeed the choice of title itself stigmatises 'chemicals' as being in need of special control, as if 'chemicals' were a class of materials that could be controlled separately, without having any connection with consumer products.

Overall the consultation appeared to confuse the control of risks from chemicals with the question of how to move to a more sustainable future. Although the two issues are related, incorporating both within one consultation document, as if they were essentially the same issue, was confusing. It was disappointing to find 'chemicals' portrayed almost entirely as a 'problem' rather than as an essential part of the solution.

The scale of the issue is also exaggerated. It is true that "tens of thousands of chemicals" have been synthesised and that a large number of these appear in inventories such as EINECS. However, more than 95% of all chemicals usage is limited to perhaps three to four thousand materials. This is still a large number, but a much more manageable problem.

The Society sought to point out the positive contributions that chemistry makes for example in understanding environmental processes and identifying potential difficulties, in monitoring and in developing greener processes.

The Society called for a vision of sustainability to be developed which would help the public and business understand the effects they have on sustainability and thus prompt progress towards achieving sustainable solutions. This would be an iterative process fraught with blind alleys and wrong turns made with the best of intentions, but it had to be done.

Less Waste, More Value - the Waste Strategy for England and Wales

This document identified the need to put a strategy for waste reduction at the heart of progress towards sustainable development, and to provide good environmental solutions for the waste that is produced.

The Society commented that while the broad thrust of the consultation was unexceptionable, it contained a number of statements which seemed to indicate lack of appreciation of some of the subtleties of the subject. In particular the document reflected compartmentalised thinking and contained generalities masquerading as facts. For example there was an implication that waste arises 'as a consequence of how efficiently we use resources'.

Although this is true waste is not always the consequence of poor housekeeping. Chemical processes are rarely simple reactions in which raw materials combine to produce a desired product. Most processes also lead to waste products being generated as a result of the stoichiometry of the reaction. These stoichiometric wastes, which are the inevitable result of the process chemistry, usually far exceed losses due to incomplete reactions or poor recovery of products. Similarly the document suggested that waste should be minimised or its toxicity reduced. This failed to appreciate that reducing the toxicity of a waste stream often leads to an increase in its mass. The Society suggested that the real solution to these problems is not better waste management or minimisation but innovative process design which eliminates the problem at source. The Society's Green Chemistry Network aims to promote such innovation.

The Society suggested that education of all sectors of the community was critical to a more sustainable waste policy. Most of the fundamental changes needed would require a revolution in our intellectual approach which must begin immediately in schools.

Sustainable Business - Sustainable Development and Business in the UK

This document identified five main themes to provide a framework for action:

- ways to encourage the development of goods and services which meet people's needs but involve use of fewer natural resources;
- promoting sustainable communities for people to live and work in;
- policies to manage and protect our environment and resources;
- sending the right signals *via* prices, regulations, and information for the public;
- and, identifying where international action is required.

Each of these themes has implications for business. The Society drew attention to its comments on the other 'sustainability' documents. It accepted that the key to developing more sustainable businesses was action by Government (regulators), Business (provider) and the Consumer (customer). However the Society urged Government to ensure that it applies consistent policies and to avoid sending perverse messages to the other stakeholders. This might require difficult decisions within a relatively simple overall strategy, a major problem being co-ordination of policy. For example, one of the key components in a sustainable economy is the use of energy. It is pointless one government department (DETR) addressing the community to use energy more efficiently whilst at the same time another government department (DTI) is putting pressure on the power utilities to reduce prices to the consumer.

The Society also argued that consumers need appropriate information in a readily understandable form, in order to make informed choices. In theory eco-labelling* should provide a valuable tool in this area. However, there has been a tendency to seek 'ultimate solutions', rather than relying on simpler, if less universal labels, such as 'energy consumption'. The Society welcomed a new 'green' standard for products in principle but would need to see further details before endorsing it.

The Business community is extremely diverse, from major multinationals to one person enterprises. The Society pointed out that these have different requirements and different drivers but that one driver applied to all businesses: the customer. Thus education of the consumer should be the most effective method to ensure that all businesses move towards sustainability.

In the Society's opinion B&Q had probably had more impact on product development in this area than all the well meaning government initiatives to date!

Business and industry should be proactive, and the Society pointed out its own efforts in this respect *via* the Green Chemistry Network, the aims of which include educating current and future businessmen in all aspects of sustainable chemistry.

[*Further information on eco-labelling can be found in a forthcoming 'EHSC Note' entitled "Eco-labelling : Life-cycle Assessment in Action" which will be available free from the EHSC Secretary, (see below)].

Copies of the Society's submissions on these and other consultations can be obtained from the EHSC Secretary:

Mr R. W. Hazell
Health, Safety and Environment Officer
Royal Society of Chemistry
Burlington House, Piccadilly
London W1V 0BN

E-mail : hazellr@rsc.org; or by telephone from Samantha Lawless on 0171 440 3304.

EHSC submissions also appear on the EHSC page as part of the RSC Website (http://www.rsc.org).

When drawing up submissions the EHSC takes advice from other relevant RSC units including the Environmental Chemistry Group, which is formally represented on the EHSC. Nonetheless producing and scrutinising submissions places a considerable burden on EHSC members who are of course all volunteers.

If you would be interested in contributing to the committee (or the fixed-term specialist Working Parties that it occasionally sets up), please contact the EHSC Secretary to obtain a copy of the committee's expertise and background questionnaire. This is simple to complete and can be returned by e-mail or in a reply-paid envelope.

The Royal Society of Chemistry's Green Chemistry Network - Further Developments

Following news of the RSC's Green Chemistry Network in the last issue of the ECG Newsletter, John Brophy reviews recent developments while Peter O'Neill suggests that the Green Chemistry Network and the ECG should co-operate, for example, in the organisation of meetings on the environment.

Recent Developments

Subsequent to the RSC Council's decision to go ahead with the Green Chemistry Network (GCN), the Management Board has met and started the process of establishing the GCN structure. Board members appointed by the RSC's Steering and Coordination Committee (SCC) include the chairman Professor David Taylor who is also chairman of the RSC's Environment, Health and Safety Committee and a member of the SCC, Dr Sue Topham from ICI who represents Industrial Affairs Division, Professor John Winfield from Glasgow University representing Education Department and Dr John Brophy representing the Secretary General.

The Management Board's first action was to appoint Professor James Clark from the University of York as the Director of the GCN. Advertisements for the post of Network Manager were placed in *Chemistry in Britain* and *New Scientist* in October. Applicants were short-listed and interviewed in November, and Mr. Mike Lancaster was appointed to start work in December. A part-time administrative assistant has also been appointed.

The role of the Management Board is to ensure that the GCN operates in line with the RSC's objectives and Charter. A technical advisory panel will also be established soon to advise and support the Director and Network Manager in developing and delivering the GCN programmes. This will comprise representatives of other Learned Societies, Industry Trade Associations, Government Departments RSC Divisions and Groups and others. We have already been approached by several bodies keen to participate. It is intended that the Technical Advisory Panel will be as inclusive as possible. Its starting line up will be announced soon.

The GCN's main focus is with chemistry as carried out in the laboratory or the process plant. This obviously has connections with environmental chemistry and vice versa and it will be important for the Network Manager to establish an early link with the Environmental Chemistry Group. There will be topics where interests coincide and the aim is to work together in synergy rather than duplicate the existing Group's efforts.

Next steps for the Network Manager are to meet the relevant RSC Groups and outside bodies, establish the detailed work programme and activate the Network.

John Brophy
Royal Society of Chemistry, Burlington House,
December 1998

Green Chemistry Network - Comments from the RSC's Environmental Chemistry Group

The Environmental Chemistry Group is generally in support of the Green Chemistry initiative and would welcome the opportunity to play an active part in its development.

There is widespread interest in environmentally related matters in the Society. The Green Chemistry Network should be of great assistance to RSC Subject Groups in the organisation and publicity of meetings that have an environmental context. At present subject groups often clash in their choice of subject matter for meetings and in the timing of meetings. It would be particularly helpful if there could be better co-ordination. The industrial slant of the GCN might also allow this co-ordinating role to be extended to include meetings organised by the Society of Chemical Industry. Better promotion of meetings through the offices of the GCN would also attract bigger audiences.

The major interests of the ECG and the GCN might appear to be different. The GCN will focus on production processes, waste minimisation and sustainability, while recently the ECG has been more concerned with changes that occur near the Earth's surface whether natural or anthropogenically modified. However this apparent separation of interests does not have sharp boundaries. Defining sustainable production methods requires a knowledge of the chemistry of the environment; changes which affect the chemistry of the environment impact on legislation and BATNEEC. Cooperation between the GCN and all sectors of the RSC who have interests in the environment (including the ECG) would seem sensible if there is not to be a duplication of effort.

Dr. Peter O'Neill
Chairman, Environmental Chemistry Group
December 1998

The Environmental Chemistry Discussion List on Mailbase

A new discussion list has recently been created on the Mailbase server. This is open to all, but will be of particular use and interest to members of the Environmental Chemistry Group.

Env-chem is a discussion forum and information exchange network concerning all areas of environmental chemistry, geochemistry and biogeochemistry, including the chemistry of terrestrial and marine aquatic environments, soil and sedimentary systems and the atmosphere. The list can be used to advertise vacancies, promote conferences and announce publications that would be of interest to members. It is however also intended to be a discussion list, so feel free to post queries, request for information or collaboration.

For those ECG members not familar with discussion lists, Mailbase has provided some background information, which is reproduced below.

Background Information

What is Mailbase?

Mailbase is the service which runs electronic discussion lists for UK academics and support staff.

What is a Discussion List?

An electronic discussion list is a list of people's names and addresses. Everyone on the list shares a common interest, such as physiotherapy or 18th century Scottish literature and they use email to talk to one another. Belonging to a list is like sitting in on a discussion. You can join in the talk, or you can just listen. You do not have to be a member of an academic institution to join a discussion list.

How do Lists Work?

You join a list by sending a message to the Mailbase computer. Your name and email address are automatically added to the list, and you will then receive all messages sent to the list by other members. You can send your reply to the list (and all the list members) or to just one person on the list. You can leave the list at any time.

Are Lists Useful?

People use Mailbase lists to discuss work with other academics, share news with other people in higher education, collaborate on projects and publications, announce conferences, arrange meetings, or just to keep in touch with colleagues in their subject area.

Is it Difficult?

No. Mailbase is very simple to use. All you really need is email. And you don't have to be an expert as the Mailbase team make a special effort to help new users.

Who is in Charge?

Each list is managed by a list owner, who is responsible for running the list - rather like a referee. They "look after" all the members, read all the messages sent out, deal with problems, and answer questions. If you have a problem joining or leaving a list, or want more information about a list, you can contact the list owner.

Getting Started

You can join, or leave, a Mailbase discussion list by sending a short message containing a command to the Mailbase computer at mailbase@mailbase.ac.uk

Joining

To join env-chem, send an email message to mailbase@mailbase.ac.uk with this command in the body of the message:

join env-chem first-name last-name [stop]

where first-name and last-name are your own personal names, (e.g. join env-chem Tony Blair).

Leaving

To leave the list, send an email message to mailbase@mailbase.ac.uk with this

command in the body of the message:

leave env-chem [stop]

To Send a Message

If you have a message (comments, questions, etc.) that you wish to send to all the members of env-chem send an email message to:

env-chem@mailbase.ac.uk

Website

Further general information about mailbase can be found at: www.mailbase.ac.uk,

while details about the environmental chemistry list appears at:

www.mailbase.ac.uk/lists/env-chem/

The Env-chem List Options

From the web site information on the list you will notice that I have used the mailbase option to ensure that only members can post messages to the list and only members can obtain details of the list members. This effectively reduces unwanted multiple posted e-mails and minimises spamming of the list.

Dr K. Nicholson
List owner
k.nicholson@rgu.ac.uk
www.rgu.ac.uk/schools/egrg/

New Publications on the Environment from the Royal Society of Chemistry (1)

Journal of Environmental Monitoring

Modern instrumentation has allowed us to push back the frontiers of detection. For instance, we are now able to determine minuscule amounts of natural and anthropogenic pollutants and contaminants in our environment (our homes, workplaces, cities, the countryside or the oceans). The ability to detect low levels of these substances does not necessarily mean that the levels present in the environment are harmful to our health or well being, but it is the ability to determine them that drives world-wide legislation.

Therefore, there is a requirement to monitor, to develop better detection methods, and to properly assess the toxicity, exposure and risk assessment of the pollutants and contaminants to which we may be exposed.

The Royal Society of Chemistry has recognised the importance of these issues and that it is essential to promote and disseminate the knowledge of newly developed technologies for monitoring our various environments. It is to meet this need that the Society are launching the *Journal of Environmental Monitoring* (JEM) which is dedicated to assessing exposure and health risks through the latest developments in measurement science. The journal, with the first issue due to be published in February 1999 and then bimonthly thereafter, is unique in that it aims to publish all the relevant information on this subject area in one source.

This journal is intended for environmental and health professionals in industry and officials from governmental and regulatory agencies as well as research scientists interested in the environment.

CALL FOR PAPERS

Submissions for the *Journal of Environmental Monitoring* are now being sought. Papers will be welcome, particularly in the following key areas:

multi-media environmental sampling and monitoring: dusts, particles, bioaerosols, gases/vapours, chemicals, radiation, physical agents, noise;

biological monitoring: chemicals and their metabolites in plasma, urine, tissue, etc., toxicokinetics, biological exposure indices, dose-response relationships, risk exposure and assessment;

advances in monitoring equipment: miniaturised/portable sensors, continuous monitors, remote sensing, scaled-up sensing technology, data acquisition and manipulation;

speciation of environmental contaminants;

legislation regarding exposure limits.

Requests for a comprehensive Guide for Authors and submissions may be forwarded to: Harpal Minhas, The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 4WF. Tel.: +44 (0) 1223432293; Fax: +44 (0) 1223 420247; email: jem@rsc.org

New Publications on the Environment from the Royal Society of Chemistry (2)

Green Chemistry

Green Chemistry is a new international journal and information resource which will be published bimonthly from Spring 1999. It will describe current research, contain reviews and report news relevant to academic, industrial and public sectors. It will cover all the chemical aspects of clean technology, and its international perspective means that it will be of interest to those carrying out research, development or manufacturing as well as to policy-makers, be they in government or industry.

The journal will consist of a mixture of full papers, reviews, communications and news and comment. *Green Chemistry* will cover all research which relates to a reduction in the environmental impact of chemicals (and fuels) whether from improved production methods, formulation and delivery systems or the use of sustainable resources. In addition to chemistry based solutions, articles describing biotechnology alternatives and improved process engineering will be included. Methodologies and tools for evaluating the environmental impact of the above, such as life cycle analysis, environmental risk analysis and legislation surrounding Green Chemistry will also be covered.

In addition to the scientific rigour expected of a premier research journal,items will be written in such a way as to be accessible to a wide audience,including for example final year undergraduate scientists and technologists. To assist in this process, articles will be prefaced by a short introductory remark, summarising the Green Chemical relevance of the paper.

The topics to be covered by *Green Chemistry* will include:

- clean synthesis
- waste minimisation/reduction
- alternative feedstocks
- water-based processes and products
- replacements for hazardous reagents
- novel separation technologies
- replacement of stoichiometric reagents
- enhanced atom utilisation by catalysts
- new safer chemicals and materials
- new solvents and reaction media
- intensive processing.

New Publications on the Environment from the Royal Society of Chemistry (3)

Issues in Environmental Science and Technology

The review series *Issues in Environmental Science and Technology* published by the Royal Society of Chemistry has long been recognised as a provider of concise, authoritative and up-to-date reviews of topical environmental issues.

An exciting new development is that subscribers to the series now have free site-wide on-line access to all volumes in the series, located on a searchable database! With two volumes published each year, covering a subject with global appeal, these titles are essential reading for scientists and engineers in the environmental science and technology field, as well as for students of environmental science.

Recent titles include Risk Assessment and Risk Management, Air Quality Management and Air Pollution and Health, with 1999 titles covering the emotive subjects of Environmental Impact of Power Generation and Endocrine Disrupting Chemicals.

As well as the subscription option, titles can be purchased individually, and an on-line pay-to-view option is available for individual articles. Full details are available on the RSC website at www.rsc.org/issues or from the Sales and Promotion Department, Thomas Graham House, Science Park, Cambridge, CB4 0WF.

The reviews published to date in *Issues in Environmental Science and Technology* are:

- Mining and its Environmental Impact (1994)
- Waste Incineration and the Environment (1994)
- Waste Treatment and Disposal (1995)
- Volatile Organic Compounds in the Atmosphere (1995)
- Agricultural Chemicals and the Environment (1996)
- Chlorinated Organic Micropollutants(1996)
- Contaminated Land and its Reclamation (1997)
- Air Quality Management (1997)
- Risk Assessment and Risk Management (1998)
- Air Pollution and Health (1998).

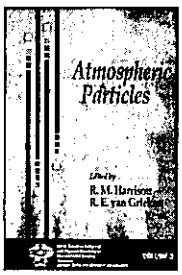
Global Reading

WILEY

IUPAC – Series on Analytical & Physical Chemistry of Environmental Systems

Series Editors: J. BUFFLE, University of Geneva, Geneva, Switzerland
& H. VAN LEEUWEN, Agricultural University, Wageningen, The Netherlands

The volumes of this series emphasize processes which are specifically related to environmental systems, systems with which chemists with a background in homogeneous reactions in solutions, may often be unfamiliar.



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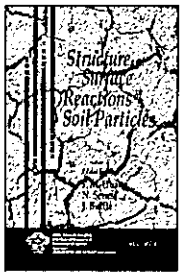

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Volume 4

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W. C. HINDS, UCLA School of Public Health, Los Angeles, USA

Following the prestigious first edition, which has established a strong following in the scientific market place, this second edition includes many new and significant changes. With a new chapter on bioaerosols and expanded information on atmospheric, background, and urban aerosols, the second edition also provides further sections on resuspension, transport losses, respiratory deposition models and fractal characterisation of particles. This book will prove to be a valuable update.

0-471-19410-7 Due Jan 1999 Hbk 450pp approx £87.95

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M. REINHARD, Stanford University, USA

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Book	*0-471 172642*	*Nov 1998*	*approx 240pp £45.50*
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Environmental Soil and Water Chemistry: Principles and Applications

V.P. EVANGELOU, University of Kentucky, USA

- Comprehensive – covers theoretical and practical aspects
- Unique examination of the interactions between soil and water to aid understanding of best methods for treating contaminated land and water
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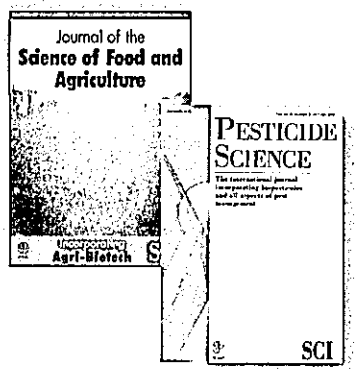

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The Federation of European Chemical Societies (FECS) and Environmental Chemistry

John Holder, a Committee Member of the Environmental Chemistry Group, reports on the current activities of the Federation of European Chemical Societies Division of Chemistry and the Environment of which he is Secretary.

The Working Party on Chemistry and the Environment is now officially a FECS Division. Recognition that environmental chemistry is a large enough branch to warrant Divisional status came with the approval of our application by the General Assembly of FECS in September 1998.

The first meeting of the new Division was at Cagliari, Sardinia on 17th October following the joint Italian Chemical Society/EU Conference on Water in the Mediterranean Area. A report of the conference will appear shortly in *Environmental Science and Pollution Research* (ESPR), the official organ of the Division.

The Sixth FECS Conference on Chemistry and the Environment, subtitled Atmospheric Chemistry and Air Pollution, took place in Copenhagen in September and was a great success with some 250 delegates attending. Full abstracts of the conference have been published in a special edition of ESPR (Vol. 5, No.3, 1998).

The Seventh FECS Conference on Chemistry and the Environment, subtitled Trace Metal Speciation in the Aquatic Environment, is scheduled for August 27-30, 2000 in Porto. The first announcement and call for papers will be out in January 1999.

The Division and its members are also involved in organisation of smaller scientific meetings and workshops. For instance, the Division is sponsoring the First International Symposium on Atmospheric Reactive Substances to be held in Bayreuth, Germany on 14-16 April 1999.

The Division initiates co-operation with other organisations in the field such as the IUPAC Division of Chemistry and the Environment, the Division of Environmental Chemistry in the American Chemical Society, and the Working Group on Chemistry in the Environment of the European Chemistry Thematic Network (ECTN). This network is *inter alia* discussing curriculum content for environmental chemistry education.

The Division has been asked by the European Environment Agency to spearhead a European equivalent of the American Presidential Green Chemistry Challenge Awards Program. Details will be published shortly.

We currently have 29 representatives from 27 countries (countries with multiple chemistry societies like Germany are allowed multiple representation but only single voting rights), the latest being Sweden, and we expect to be joined by a Dutch representative in time for our next Committee meeting in Bayreuth in April.

The role of the Division in research co-ordination will be will be of increasing importance and many members have already agreed to assist environmental chemistry research groups find partners for Framework 5 bids. We are particularly interested in advancing research in the smaller member countries, candidate EU member states and Eastern Europe generally. A full list of committee members is published on our web pages which are now accessible through the RSC on

http://www.chemsoc.org/gateway/fecs.htm

If you are interested in the activities of the Division and would like to know more, I will email you a copy of our latest minutes on request.

John V. Holder
Faculty of Science, University of Central Lancashire email j.v.holder@uclan.ac.uk
November, 1998

Forthcoming Symposium

Royal Society of Chemistry Environmental Chemistry Group

Chemical Contaminants in Estuaries and Coastal Waters: Practical Applications of Models

The Environmental Chemistry Group will be holding this one-day symposium at the Scientific Societies' Lecture Theatre, New Burlington Place, Savile Row, London on Wednesday 3rd February 1999 from 1015 - 1600.

There is an increasing reliance on models to forecast the distribution, movement and fate of chemicals, whether of natural or anthropogenic origin. Environmental chemists and others who study estuaries and coastal waters need to appreciate the strengths and weaknesses of these models. Similarly, policy makers and enforcement agencies need to understand the capabilities of the models that are used to inform their activities.

The aim of this meeting is to provide a synopsis of the use of various modelling techniques in the study of the distribution and movement of contaminants in estuaries and coastal waters. The speakers will provide an informed picture of:

(a) where we are at present in modelling chemicals in estuarine and coastal waters;

(b) practical examples of models and the information that can be provided by them;

(c) some of the practical and theoretical problems in improving models.

Chemical Contaminants in Estuaries and Coastal Waters: Practical Applications of Models

PROGRAMME:

10.15 - 10.45 Registration. Coffee/tea.

10.45 - 11.25 Use of models by the Environmental Agency. Dr Neil Murdoch and Dr Peter Jonus (Environment Agency)

11.25 - 12.05 Contamination distribution in estuaries and the use of GIS. Dr Andy Tyler (BMT)

12.05 - 12.45 Flexible modelling using ECOS. Dr John Harris (CCMS, Plymouth)

12.45 - 13.55 Lunch

13.55 - 14.35 Modelling radionuclide transport in coastal waters. Dr Susan Clarke (Westlakes Research)

14.35 - 15.15 Modelling nutrient behaviour in estuaries and coastal waters. Dr David Hydes (Southampton Oceanographic Centre)

15.15 - 15.55 Computer simulation of oil and chemical spills in estuaries and coastal waters. Professor Alan Elliot (Bangor University)

15.55 Close of meeting

The Scientific Societies' Lecture Theatre is situated in New Burlington Place, off Savile Row and behind Regent Street (opposite side to Hamleys). The nearest tube station is Oxford Circus.

To register for this meeting, please use a photocopy of the application form printed below.

Chemical Contaminants in Estuaries and Coastal Waters: Practical Applications of Models

Scientific Societies' Lecture Theatre Wednesday 3rd February 1999

I wish to register for the Symposium on 3rd February 1999:

I enclose a cheque made payable to "RSC Environmental Chemistry Group"	(Charge includes lunch and coffee/tea)
Members of the RSC Environmental Chemistry Group	£60.00
RSC retired members	£17.00
Other members of the RSC	£65.00
Non members	£95.00
Students in full-time education (indicate university/college)	£17.00

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Dr P. O'Neill, Faculty of Science, University of Plymouth, Drake Circus, Plymouth PL4 8AA
Tel.: 01752 232984 Fax: 01752 233095

Forthcoming Symposium

Royal Society of Chemistry Environmental Chemistry Group

Distinguished Guest Lecture and Accompanying Symposium for 1999

The Environmental Chemistry Group will be holding a half-day symposium on *Radiatively-Active and Ozone-Depleting Trace Gases in the Atmosphere* at the Royal Society, 6 Carlton House Terrace, London on Wednesday March 3rd 1999.

At this meeting the **ECG 1999 Distinguished Guest Lecture** will be given by the Professor Mario Molina from the Massachusetts Institute of Technology. The title of Professor Molina's lecture is *Global Atmospheric Chemistry Challenges for the Coming Decade.*

Professor Molina won the 1995 Noble Prize for Chemistry (with Prof. Paul Crutzen and Prof. F.S. Rowland) for his work explaining the depletion of ozone in the stratosphere.

The Distinguished Guest Lecture will be part of a half-day symposium which starts at 13.30.

Two supporting lectures will be given at the symposium:

The History of Atmospheric Measurements at Mace Head, Ireland: Implications of the Changing Trends in Natural and Anthropogenic Trace Gases (Prof. Peter Simmonds, Bristol University) and

Policy Approaches to the Control of Radiatively-Active and Ozone-Depleting Trace Gases (Dr David Fisk, Chief Scientist, Department of the Environment, Transport and the Regions, London).

Demand for this meeting is expected to be high and an early indication of your wish to attend is advised. To reserve a seat please complete the form which accompanies this Newsletter, and mail it to the Group's Honorary Secretary, Dr. Leo Salter, Cornwall College, with a cheque for £10.00 **(ECG members are entitled to free admittance).** Alternatively, use a photocopy of the registration form which is printed below.

The ECG Distinguished Guest Lecture and accompanying symposium for 1999 is sponsored by the RSC's Angela and Tony Fish Bequest Fund.

The London Underground stations nearest to the Royal Society are Charing Cross, Green Park,or Piccadilly Circus.

Professor Mario Molina - The ECG Distinguished Guest Lecturer for 1999

Details of Professor Molina's Nobel Prize winning work on the effect of CFCs on the ozone layer may be found on The Nobel Prize Internet Archive Website at http://www.almaz.com/nobel/chemistry/1995b.html

Professor Molina's Nobel Lecture was published in *Angew. Chem.*, Int. Ed., 1996, **35**, 1778-1785.

An account of Professor Molina's pre- and post-doctoral training which laid the foundation for his key paper [*Nature* (June 28th), 1974, **249**, 810-812] on the reactions of chlorine atoms with atmospheric ozone appears on the Website for the Nobel Foundation at http://www.nobel.se/laureates/chemistry-1995-2-autobio.html

Professor Peter Simmonds is visiting Industrial Professor in the School of Chemistry at Bristol University. His research interests there are focused on the development of automated, ultrasensitive, analytical instrumentation which can be used at remote monitoring stations to determine the lifetimes and trends of environmentally sensitive trace gases.

After completing his PhD, Peter Simmonds worked at the California Institute of Technology Jet Propulsion Laboratory where he developed a gas chromatograph-mass spectrometer which was flown successfully on NASA's Viking mission to Mars in 1976. For the past twenty years Professor Simmonds has been a member of a team of scientists concerned with the long-term measurement of atmospheric trace gases, particularly those implicated in ozone depletion and climate change.

Royal Society of Chemistry Environmental Chemistry Group Distinguished Guest Lecture and Symposium 1999

Radiatively-Active and Ozone-Depleting Trace Gases in the Atmosphere

Wednesday March 3rd 1999 at The Wellcome Lecture Hall, The Royal Society, 6 Carlton House Terrace, London SW1.

PROGRAMME
(Sponsored by the RSC's Angela and Tony Fish Bequest Fund)

13.30 Chairman's Introduction, Dr P. O'Neill (Chairman, RSC Environmental Chemistry Group)

13.35 Professor Peter Simmonds (University of Bristol) *The History of Atmospheric Measurements at Mace Head, Ireland: Implications of the Changing Trends in Natural and Anthropogenic Trace Gases*

14.20 Dr David Fisk (Chief Scientist, Department of the Environment, Transport and the Regions) *Policy Approaches to the Control of Radiatively-Active and Ozone-Depleting Trace Gases*

15.05 Tea and Environmental Chemistry Group Annual General Meeting

15.35 Introduction to the 1999 Environmental Chemistry Group Distinguished Guest Lecture

15.40 1999 RSC Environmental Chemistry Group Distinguished Guest Lecture: *Global Atmospheric Chemistry Challenges for the Coming Decade*
Professor Mario Molina (Massachusetts Institute of Technology)

16.40 Open Forum

17.00 Close

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 the Hon. Secretary by means of the slip below. There will be a charge of £10 for non-members of the Environmental Chemistry Group (cheques made payable to RSC Environmental Chemistry Group) which should be returned with the slip.

ROYAL SOCIETY OF CHEMISTRY ENVIRONMENTAL CHEMISTRY GROUP

Twenty-sixth Annual General Meeting, March 3rd 1999 and Distinguished Guest Lecture and Symposium on, *"Radiatively Active and Ozone-Depleting Trace Gases in the Atmosphere"*

Please tick the item(s) below as appropriate and return to:
Dr Leo Salter,
Research Director,
Cornwall College,
Pool,
Redruth,
CORNWALL TR15 3RD.

Name: .....

I would like to attend: ☐ The AGM: ☐

The Symposium: ☐ The Distinguished Guest Lecture: ☐

I enclose a cheque for £10.00 (non-members of the ECG only) ☐

Society for Environmental Geochemistry and Health (SEGH)

Forthcoming Symposia

SEGH 17th European Conference

This two-day conference will have two thematic sessions:

(i) Pollution of the Urban Environment

(ii) Pollutant Transport Processes

In addition there will be an open session covering all aspects of environmental geochemistry and health. Following the conference, a field trip to the former lead mine at Tyndrum and slate quarry at Ballachuilish is provisionally planned.

Location: University of Glasgow and The Scottish Universities Research and Reactor Centre, UK, 29-31st March 1999

Contact: Dr. A.B. MacKenzie
Scottish Universities Research and Reactor Centre
Rankine Avenue
Scottish Enterprise Technology Park
East Kilbride, Scotland, UK G75 0QF
Tel.: +44 (0)1355 270141
Fax: +44 (0)1355 229898
E-mail: A. MacKenzie@surrc.gla.ac.uk.

GEOTROP-99 Third International Conference on Environmental Chemistry and Geochemistry in the Tropics

Location: Hong Kong University, 24-26th November 1999

Contact: The Conference Secretariat
Institute for Natural Resources and Waste Management
Hong Kong Baptist University
Kowloon Tong
Hong Kong
Tel.: 852 23 397 054
Fax: 852 23 361 400
E-mail: Geotrop@hkbu.edu.hk

5th International Symposium on Environmental Geochemistry

Cape Town, South Africa
24-28th April 2000

Fourth International Conference on Arsenic Exposure and Health

USA
18-22 June 2000

Forthcoming Symposia

Details of many meetings related to the environmental sciences to be held in the first half of 1999 are given in the leaflet *Environmental Science and Technology Meetings* (No. 29, December 1998) which accompanies this issue of the ECG Newsletter.

Other symposia on environmental and related topics which have come to our attention are as follows:

Chemical Contaminants in Estuaries and Coastal Waters: Practical Applications of Models

Organised by the RSC Environmental Chemistry Group, Wednesday 3rd February 1999, Scientific Societies' Lecture Theatre, New Burlington Place, Savile Row, London (Dr. Peter O'Neill, tel: 01752 232984 for details - see also elsewhere in this Newsletter).

Atmospheric Deposition on Agricultural Land

Organised by the SCI Agricultural & Environmental Group, Tuesday 16th February 1999, SCI, 14/15 Belgrave Square, London (Professor B.J. Alloway, tel: 0118 931 6581 for details).

Human Health Risk Assessment of Chemicals - Regulatory Approaches

Organised by the RSC Occupational and Environmental Toxicology Group and the Chemical Hazard and Risk Special Interest Group of the British Occupational Hygiene Society (BOHS), Wednesday, 17th February 1999, The Huxley Conference Centre, London Zoo, Regents Park, London NW1 (contact the BOHS for details, tel: 01332 298101 - registration is required by Friday 5th February at the latest).

Radiatively Active and Ozone-Depleting Trace Gases in the Atmosphere

Organised by the RSC Environmental Chemistry Group, Wednesday 3rd March 1999, The Royal Society, 6 Carlton House Terrace, London SW1 (Dr. Leo Salter tel: 01209 712911 for details - see also elsewhere in this Newsletter).

Rapid Detection Assays for Food and Water

Organised by the RSC Water Chemistry Forum and the RSC Environmental Chemistry Group, 15th - 17th March 1999, Central Science Laboratory, York (Elaine Wellingham, Conference Secretariat, tel: 01275 853311 for details).

Meeting Report: Biological and Environmental Applications of ICP-MS and ICP-OES

This meeting was held at the Macaulay Land Use Research Institute (MLURI), Aberdeen, Scotland on 24th June 1998. It was organised with the financial assistance of several groups within the RSC: the Scottish Regional Group of the Analytical Division, the Aberdeen and North of Scotland Local Section, the Environmental Chemistry Group and the Angela and Tony Fish Bequest. The latter Bequest is administered through the RSC Awards Committee, and their generous support enabled us to invite distinguished speakers from many of the most research-active ICP laboratories in the UK.

Eight papers were presented and the meeting attracted over 40 delegates, including a number of research students who used the occasion to present posters of their work. It was gratifying to see that many of our delegates made the journey from England to attend the conference. Although ICP is making an increasing impact on the analytical stage, the ICP-MS community is still relatively small and tightly knit. The result of this is that organisers of meetings on ICP-MS can always rely on speakers to contact one another and thereby prevent repetition!

The meeting began with a presentation from Dr Hywel Evans (University of Plymouth) on 'The Determination of Actinide Elements in Environmental Samples using Chelation Pre-concentration with ET-V-ICP-MS.' This was followed by Dr David Lyon (Glasgow Royal Infirmary) who described some clinical applications of ICP-MS - concentrating mainly on antimony and its proposed role in cot deaths. Dr Ben Fairman (LGC, Teddington) then reviewed 'The Principles, Practice and Applications of Isotope Dilution ICP-JMS' which provided the audience with an insight into the intricacies of preparing certified reference materials. The final paper of the morning session, from Dr John Lewis (MAFF, Norwich), was entitled, 'The Use of HPLC-ICP-MS and CE-ICP-MS to Investigate Elemental Speciation in Human Nutrition Studies.'

In the afternoon the chair was taken by Dr Alistair Smith (MLURI, Aberdeen) and began with Dr Barry Sharp (Loughborough University) who reported some new developments in ICP-MS and methods for enhancing the information content of this technique. Professor Cameron McLeod (University of Sheffield) returned to bioscience applications with a lecture on 'Speciation Research: from Environmental to Biomedical Systems' in which he described the determination of bromate in drinking water and the characterisation of metal binding proteins in biological fluids. Following this, Dr Fergus Keenan (VG Elemental) talked about 'Clinical Applications of Laser Ablation ICP-MS' in which he reviewed his own research into the element profiling of teeth as an indication of exposure to metals in the environment. Finally, to complete a long but fascinating day, Dr Gareth Newman (MLURI, Aberdeen) gave a detailed overview on the 'Effects of Spectral Interferences in the Analysis of Cu, Cd and Pb in Soils by ICP-OES.'

For those that were able, it was useful to be able continue discussions into the evening over a pleasant meal and a few drinks in the local hotel. At moments like this Aberdeen's location does have its advantages, enabling us to question our guests at length as they waited for aircraft or sleeper trains!

Dr Brian A. McGaw and
Dr Keith Nicholson Reader in Environmental GeochemistrySchool of Applied Sciences, The Robert Gordon University, Aberdeen AB25 1HG, Scotland. Tel: +44 1224 262800
Fax: +44 1224 262828
e-mail: k.nicholson@rgu.ac.uk
Web: http://www.rgu.ac.uk/schools/egrg/
discussion group: http://www.mailbase.ac.uk/lists/env-chem/

Meeting Report: The 6th FECS Chemistry and the Environment Conference

Atmospheric Chemistry and Air Pollution was the subject for the 6th Federation of European Chemical Societies (FECS) and the Environment Conference held in Copenhagen on August 26th-28th 1998.

Both the plenary and supporting lectures demonstrated the continued high level of attention being given to the causes and impacts of pan-European tropospheric pollution. VOCs, ozone and nitrogen oxides from many different sources are being monitored in the field and also modelled and studied in laboratory situations in order to provide European Union (EU) legislators with a firm platform for decision making; not the least part of the work being performed is that focused on harmonising EU quality assessment for monitoring methods.

Ozone and PM_{10} attract particular research interest because of their long-range trans-border transport and, in the case of PM_{10}, because of the difficulties with reaching agreement on acceptable instrumentation. Other research on health effects of VOCs such as benzene serves to emphasise the long overdue need for legislation. Biogenic sources of VOCs and impacts of tropospheric pollution on the biosphere were also well represented in the lectures - things have come a long way since simple hypotheses based on acid rain!

Classical studies of UK VOC oxidation using chemical modelling (M.J. Pilling *et al.* from the Leeds group - see also ECG Newsletter No.8, pp.6-7), cross-European monitoring of benzene exposure (Sacco and Cootie, Padova), studies of PM_{10} (Harrison and Ji Ping Shi, Birmingham) and work on heterogeneous reactions (Amman *et al.*, Switzerland; Davies and Cox, Cambridge) are all worthy of fuller examination when the full papers finally appear in the published literature - but this is a very personal selection!

(The abstracts of the lectures are presented in *Environmental Science and Pollution Research*, 1998, **5** (3), 119-134).

Leo Salter

Meeting Report: On-Line Analysis in the Environment

Mike Daniel, a committee member of the Environmental Chemistry Group, reports on a meeting organised jointly by the ECG and the NE region of the Analytical Division and held at Headingley Rugby and Cricket Club, Leeds on Wednesday November 18, 1998.

On-Line Analysis in the Environment focused, with two exceptions, on the production of analytical data which require a minimum of operator intervention for the protection of raw water supplies.

Professor Peter Myers (Xtec Consulting Ltd.) began the day with an insight into how technology may make future instruments truly portable by using modern chip technology and incorporating electrical driven separations along the lines of conventional capillary electrophoresis.

Professor Vreuls (Vrije University) returned us to the present with an account of his work in Amsterdam. He described methods for the automation of the preparation of aqueous samples on-line with liquid chromatography and capillary gas chromatography. Both approaches use solid-phase extraction for analyte enrichment and transfer *via* an appropriate interface, *viz.* an on-line injector and retention gap for GC, while a switching valve suffices for LC coupling.

Several successful applications were shown and the use of MS detection appeared to be very powerful. Analytical data showed that recovery (75-105%), repeatability (2-10%) and linearity (0.1-5 µg/l) were fully satisfactory. Detection limits for all the applications shown were less or at the 0.1 µg/l level.

The next three speakers summarised their respective companys' approaches to river intake protection arising from local circumstances, and how the instrumentation has evolved over the years.

Dr I. Fowlis (AES Horsley, Northumberland) described analysis on the River Tyne and Tees using the Samos™ system with diode-array detection for phenols and an on-line MS system for VOCs.

Dr. M. Purvis (Severn Trent Laboratories, Coventry) reviewed ten years experience on the River Trent with an automatic monitoring system for key parameters (*e.g.* phenoxy herbicides, triazines and bromide). This instrument allows river abstraction to cease if threshold values are exceeded and also minimises the use of activated charcoal at the treatment works.

R. Whiteman (Hyder Environmental Ltd., Runcorn) described a similar system in use on the River Dee. Electrochemical detection had been replaced by fluorescence detection for the measurement of phenols.

In the final presentation of the meeting, Mike Daniel from the Environment Agency gave a presentation on the NLS work at Leeds and Llanelli involving the use of a Prospekt™ and Samos™ systems.

Using these techniques, linear alkyl sulphonate and alkyl phenol ethoxylate detergents were analysed with fluorescence detection as were the herbicides Glyphosate and Asulam. Phenyl urea herbicides and Carbendazim were analysed using MS and some preliminary work with octyl phenol and octyl phenol ethoxylates was also successful with MS detection.

The seminar was reasonably well attended in excellent facilities at the home of Yorkshire cricket, with an excellent standard of presentations leading to a thoroughly enjoyable day which we hope to repeat in a few years time.

Mike Daniel
Environment Agency
NLS Leeds

Book Review

Principles of Environmental Toxicology

Ian C. Shaw and John Chadwick, Taylor and Francis, London, 1998, 216pp., £14.95, Softback, ISBN 0-7484-0356-6

This book arose from the MSc course 'Environmental Toxicology' at the University of Central Lancashire. It provides a broad overview of the subject from the development of environmental pollution, the effects on ecosystems, the fate and behaviour of chemicals in the environment, toxicity testing and human toxicology, environmental monitoring and analysis, and risk assessment to legislation and chemical controls. It fills a significant gap in the market and provides an excellent, modestly priced course text for chemistry, biology or environmental science degrees containing modules on environmental toxicology.

The book is clear and understandable with a somewhat quirky style that makes it all the more interesting to read. The authors' personal experience of pesticide regulations shows through in the many case studies and illustrated examples. Of necessity it is general in approach and specialists might find some chapters, especially those on radioactivity in the environment and analytical techniques a little superficial. The chapter on legislation on its own is worth the price of the book. It manages to make this dry (to me) topic readily digestible and contains a fine review of the main statutory provisions governing the control of chemicals in the environment.

The book is already proving popular and a second printing is due shortly which will eliminate most of the minor typographical errors, although we may have to wait until a second edition appears to overcome the rather basic reproduction of some of the illustrations. These criticisms are minor however and the book will have wide appeal not just to scholars but also to environmentalists, regulators and industrialists.

John Holder
December 1998

Book Reviews

The following reviews of some recently-published environmental books first appeared on the Website of the *The Analyst.*

Encyclopedia of Environmental Analysis and Remediation

Editor-in-Chief: Robert A. Meyers, 8 volumes. (Volumes 4 and 7 supplied for review),J. Wiley, 1998, £1650.00, ISBN 0-471-11708-0.

Commissioning and editing 280 articles with 3,000 pages covering the whole subject of environmental sampling, analysis and remediation is a huge task, but this is what Robert Meyers has done in the *Wiley Encyclopedia of Environmental Analysis and Remediation.* He has produced a superb reference text extending over eight very large volumes, each packed with clearly presented, well illustrated, relevant and up-to-date information.

The scope of the encyclopedia may be judged by the length of the index, covering more than 50 pages with around 10,000 individual subject entries.

The quality of the articles is superb, and is indicated by the eminence of some of the contributors. Many will be familiar to readers of *The Analyst,* and in the reviewer's own field of atmospheric chemistry include Fred Adams, Ian Barnes, Rene van Grieken, John Seinfeld and Robert Slevers.

One possible criticism is the predominant use of North American authors, although the undoubted quality of their contributions negates this concern.

The level of coverage of the individual articles is rather variable, but in general is high, and certainly high enough for the average post-graduate student to find useful. If one wanted, for example, a ten-page description of infrared spectroscopy, or ion chromatography, or radon or hydrocarbons in the atmosphere, or the destruction of hazardous laboratory waste (....the list is endless!) then this is the book to reach for.

Of course given the price, it may not be so easy to reach for, and a walk to the library will probably be required, but that walk would be well worthwhile.

This is an excellent compendium and every university library and environmental chemistry laboratory should save up for it.

C.N. Hewitt
(Lancaster University, Lancaster, UK)

Commercial Biosensors: Applications to Clinical, Bioprocess, and Environmental Samples

Graham Ramsay (ed.). Chemical Analysis: A Series of Monographs on Analytical Chemistry and Its Applications, Volume 148. Pp. xvi+304, J. Wiley, 1998. (Hardcover) £60.00, ISBN 0-471-58505-X.

Commercial Biosensors provides a comprehensive, and in-depth analysis of the most significant developments and applications of commercial biosensors in recent times. This book gives an excellent overview of the pivotal role that biocomponents play in the diverse areas of clinical analysis, the bioprocess industry, and the analysis of environmental samples. This timely and extensive book will be an invaluable reference for students and professionals in the medical and bioprocess communities.

With few exceptions, the contents of various chapters are well coordinated and the writing and presentation style is highly uniform throughout the work.

For researchers involved in sensor development in academic environments, it serves to illustrate the many difficulties that are encountered in bringing sensors to the marketplace and emphasises that for commercial success, close attention must be paid not only to elegant transduction mechanisms, but also to high quality, reliable and robust product design.

Robert J. Forster
(Dublin City University, Dublin, Ireland)

Environmental Chemistry of Selenium

William T. Frankenberger, Jr. and Richard A. Engberg (eds.). Books in Soils, Plants, and the Environment, Volume 64, pp. xvii+714, 1998, ISBN 0-8247-0136-4.

Selenium presents something of a problem in the environmental sciences. In selenium-deficient regions, dietary supplementation may be deemed necessary and has resulted in many beneficial effects for the healthy development of ruminants and livestock. However, in areas where there is an abundance of selenium in soils and groundwater, a detrimental impact on wildlife and domestic animals has been observed.

Both aspects of selenium's dichotomous behaviour are thoroughly described in this book. We are treated to the entire spectrum of information on the environmental chemistry of selenium, and more. Various chapters address regulatory aspects, analytical methods, toxicology, and contamination remediation issues.

But, as is often the case in a book of many authors, there is considerable overlap between chapters covering the same topic. This means that the text is unnecessarily long, and the repetition of information tends to diminish the enjoyment of reading. For example, chapters 5-9 all look at dietary supplementation. On the one hand, I found this part of the book perhaps the most interesting (we inhabitants of selenium-deficient Sweden probably eat more 'bioselenium' tablets than people living anywhere else in the world). On the other hand, some co-operation between the authors could have provided a single chapter that more concisely compared approaches and conclusions reached, following supplementation studies in various selenium-deficient regions.

The toxicology aspects covered in chapters 16-19 could also have benefited from more efficient summarisation.

Chapters 2-4 discuss the challenges in

detecting minute levels of selenium with state- of-the-art instrumentation in water, soil, and plants. However, chapters 2 and 3 also suffer from severe overlap, both discussing and focusing on neutron activation analysis, fluorimetry and hydride generation atomic absorption spectrometry. Brief mention of the inductively coupled plasma, electrothermal atomization and mass spectrometric techniques is also made, but there is no critical comparison regarding the potential merits and disadvantages each has to offer.

It would have been much better to provide a single, more detailed, chapter which would have assisted the reader in selecting a suitable analytical approach for a particular application within the scope of the book. In chapter 4, the sequential extraction of selenium oxidation states is described, along with some reference to chromatographic speciation approaches, and is well worth reading. Otherwise I found the methods, often based on mass spectrometry, applied in the parts on remediation of selenium contamination (chapters 23-29) much more informative and illustrative of the capabilities of modern analytical instrumentation.

To conclude, the book provides a valuable overview of the environmental chemistry of selenium. A wealth of information is presented, but there is a rather disturbing amount of repetition. It would have been beneficial to have included an introductory chapter describing the numerous selenium species that have been identified in various environmental compartments, and how these interact and react. This information is available, but is distributed throughout the text, and thus any synopsis of selenium's environmental chemistry is, unfortunately, left to the reader.

Douglas C. Baxter
(University of Technology, Lulea, Sweden)

Statistical Methods for Environmental and Agricultural Sciences. Second edition

A. Reza Hoshmand, pp. 440, CRC Press. 1997, £74.95, ISBN 0-8493-3152-8.

This textbook, intended primarily for undergraduate students of agricultural and environmental sciences, consists of six different but coherent parts.

Part I is an introduction on statistics in general, and measures of central tendency and variability are also covered. Part II contains three chapters, which give the fundamentals of probability theory, sampling concepts and parameter estimation, respectively. Part III describes the ideas of hypothesis testing and analysis of variance. Part IV on nonparametric methods contains two chapters, one on Chi-square analysis, and the second on other types of basic nonparametric tests, among them the sign test and Wilcoxon's rank test. Part V describes all basic aspects on simple and multiple linear regression with additional paragraphs on curvilinear models. Part VI covers two topics, time series analysis and index numbers.

Some statistical subject-areas are neglected: the analysis of data which is not normally distributed; the occurrence of autocorrelation in time series; and experimental design.

In conclusion, this book is a well-written introductory textbook, which covers most of the elementary statistical subjects used in environmental and agricultural sciences.

Margriet Hendriks
(Centre for Biometry, Wageningen, The Netherlands)

Aerosol Particle Size Analysis: Good Calibration Practices

W.D. Griffiths, D.Mark, I.A. Marshall and A.L. Nichols, pp. viii+116, The Royal Society of Chemistry, 1998, £45.00, ISBN 0-85404-452-3.

Aerosol science has been a poorly supported discipline in the UK. For many years the only well funded areas tended to be those of chemical and biological defence and radioactive aerosols. The UK conducted some excellent work, but much of it was classified and the results never saw the light of day, and there was rather little exchange of expertise with the wider research community.

Over the past 10 years or so, however, the subject of aerosol science has undergone a renaissance in the UK largely because of its importance in occupational and environmental health. Indeed, nowadays, airborne particulate matter is the air pollutant attracting by far the greatest attention because of its substantial impacts on public health and current uncertainties over the mechanism of action. Increasingly, the importance of aerosol science is being recognised in other fields, for example, in the industrial production of high performance materials.

There is, therefore, a clear need for agreed measurement protocols and high quality reference materials. This book was therefore produced as "a manual of good calibration practices" with guidance from the National Calibration Forum for Aerosol Analysis established through a Valid Analytical Measurement Programme (VAM 14) of the National Measurement System Policy Unit of the UK Department of Trade and Industry.

The book reads rather like a textbook. After two introductory chapters dealing with a few of the basics, there is a short chapter on general considerations dealing with generic issues such as measurement and uncertainty and traceability. There follow two substantial chapters, the first rather surprisingly entitled "Ancillary Considerations" which deals with techniques for generating aerosols; the second on "Calibration Procedures for Aerosol Particle Size Analysers". The latter comprises almost a half of the total book. The approach in this chapter is to identify specific particle sizing instruments down to the make and model number and to highlight the measurement principles and then to recommend procedures for calibration. This is especially useful to the practitioner since many of these instruments come factory-calibrated with a manual which could easily lead the inexperienced user to believe that calibration issues are an irrelevance and the instrument will simply provide reliable data. This is often far from the case and experimentally derived calibrations, or at least an appreciation of the factors which influence the response of the instrument, are frequently a prerequisite to making sound measurements. To my knowledge this is the only currently available book taking this approach to the calibration of

aerosol instruments. As such, it can be strongly recommended.

The focus of the book is entirely on the question of aerosol particle size analysis. The question of particle numbers is not directly addressed. The style is lucid, the treatment authoritative and the coverage of techniques reasonably comprehensive. The book is therefore a valuable, short guide to those in industry, research or consultancy with a need to make reliable measurements of airborne particles.

Roy M. Harrison
(The University of Birmingham, UK)

These five book reviews are reproduced by permission of the Royal Society of Chemistry. More reviews of general-interest analytical science books are available at www.rsc.org/analreview.

Recent Books on the Environment and on Toxicology at the RSC Library

The following books and monographs on environmental topics have been acquired by the RSC library, Burlington House, during the period June to December 1998. Recent additions on toxicology are also included in this list.

ISO 14001: A Missed Opportunity for Sustainable Global Industrial Development

Krut, R. *et al,* Earthscan, London, 1998, ISBN/ISSN:1853835072, 160 pp. Accession No: 980372, West Gallery

Chromatographic Analysis of Environmental and Food Toxicants

Shibamoto, T. (ed.), Marcel Dekker, New York, 1998 ISBN/ISSN:0824701453, 331 pp., Accession No: 980377, Reading Room, 543.544

Review of R&D Programme 1996/97: for the Period April 1996 to March 1997

Environment Agency, Stationery Office, London, 1998, ISBN/ISSN:011310149X, 90 pp., Accession No: 980383, West Gallery, 628.5:061.62

Financial Assistance for Environmental Purposes (No. 3) Order 1998

Stationery Office, London, 1998, ISBN/ISSN:011065935X, 2 pp., Accession No: 980384, A 99, SI 1998/1001

Environmental Protection (Waste Recycling Payments) (Amendment) Regulations 1998

Stationery Office, London, 1998, ISBN/ISSN:0110657691, 4 pp., Accession No: 980385, A 99, SI 1998/607

Environmental Protection (Controls on Hexachloroethane) Regulations 1998

Stationery Office, London, 1998 ISBN/ISSN:0110656474 4 pp. Accession No: 980386, A 99, SI 1998/545

Environment Act 1995 (Commencement No. 11) Order 1998

Stationery Office, London, 1998, ISBN/ISSN:0110658256, 4 pp., Accession No: 980387, A 99, SI 1998/604 (C.11)

Highway Litter Clearance and Cleaning (Transfer of Responsibility) Order 1998

Stationery Office, London, 1998, ISBN/ISSN:0110656008, 6 pp., Accession No: 980388, A 99, SI 1998/467

Controlled Waste (Registration of Carriers and Seizure of Vehicles) (Amendment) Regulations 1998

Stationery Office, London, 1998, ISBN/ISSN:011065739X, 2 pp., Accession No: 980389, A 99, SI 1998/605

Environmental Protection (Prescribed Processes and Substances) (Amendment) (Hazardous Waste Incineration) Regulations 1998

Stationery Office, London, 1998, ISBN/ISSN:0110657586, 6 pp., Accession No: 980390, A 99, SI 1998/767

Financial Assistance for Environmental Purposes Order 1998

Stationery Office, London, 1998, ISBN/ISSN:0110657616, 2 pp., Accession No: 980391, A 99, SI 1998/538

What is Safe?: The Risks of Living in a Nuclear Age

Williams, D.R., Royal Society of Chemistry, Cambridge, 1998, ISBN/ISSN:0854045694, 146 pp., Accession No: 980398, West Gallery, 614.8

Expert Group to Investigate Cot Death Theories: Final Report May 1998

Lady Limerick, Department of Health, London, 1998, ISBN/ISSN:1858398746, 365 pp., Accession No: 980524, West Gallery, 614.8

Chlordimeform

WHO, Geneva, 1998, ISBN/ISSN:9241571993, 159 pp., (Environmental Health Criteria No. 199), Accession No: 980562, West Gallery, 628.5

Environment, Health and Safety 1997: Ciba Speciality Chemicals

Ciba Speciality Chemicals, Cheshire, 1998, 20 pp., Accession No: 980571, Reference Shelves, REF 06.055.5:628.5:614.8 R

Guidelines for Controlling and Monitoring the Tobacco Epidemic

WHO, Geneva, 1998, ISBN/ISSN:9241545089, 190 pp. Accession No: 980575, West Gallery, 614.8:663.97

Environmental Chemical Analysis

Kebbekus, B.B. *et al.,* Blackie, London, 1998, ISBN/ISSN:075140456X, 330 pp., Accession No: 980615, West Gallery, 628.5:543

King's Safety in the Process Industries, 2nd Edition

King, R. *et al.,* Arnold, London, 1998, ISBN/ISSN:0340677864, 661 pp., Accession No: 980626, West Gallery, 614.8:66.01

Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes

Anastas, P.T. *et al.* (eds.), Oxford University Press, Oxford, 1998, ISBN/ISSN:0198501706, 364 pp., Accession No: 980629, West Gallery, 66:628.5

List of MAK and BAK Values 1998: Maximum Concentrations and Biological Tolerance Values at the Workplace Report No. 34

Wiley-VCH, Weinheim, 1998, ISBN/ISSN:3527275851, 220 pp., Accession No: 980683, Reference shelves, 1998, 614.8

Green Chemistry: Theory and Practice

Anastas, P.T. *et al.*, Oxford University Press, Oxford, 1998, ISBN/ISSN:0198502346, 135 pp., Accession No: 980686, West Gallery, 1998, 628.5:54

Hamilton & Hardy's Industrial Toxicology, 5th Edition

Harbison, R.D., Mosby, St. Louis, 1998, ISBN/ISSN:0815141815, 682 pp., Accession No: 980688, West Gallery, 615.9

The State of the Environment of England and Wales: Fresh Waters

The Stationery Office, London, 1998, ISBN/ISSN:0113101481, 214 pp., Accession No: 980715, West Gallery, 628.5

Environmental Technology Network Directory

Royal Society of Chemistry, Burlington House, London, 1998, 197 pp., Accession No: 980749, Reference Shelves, REF 058.7:628.5:62 R

Eye Irritation Reference Chemicals Data Bank, 2nd Edition

ECETOC, Brussels, 1998, ISBN/ISSN:0773807248(2), 236 pp., (ECETOC Technical Report No. 48 (2)), Accession No: 980756, West Gallery 615.9

QSARs in the Assessment of Environmental Fate and Effects of Chemicals

ECETOC, Brussels, 1998, ISBN/ISSN:0773807274, 136 pp., (ECETOC Technical Report No. 74), Accession No: 980757, West Gallery, 615.9

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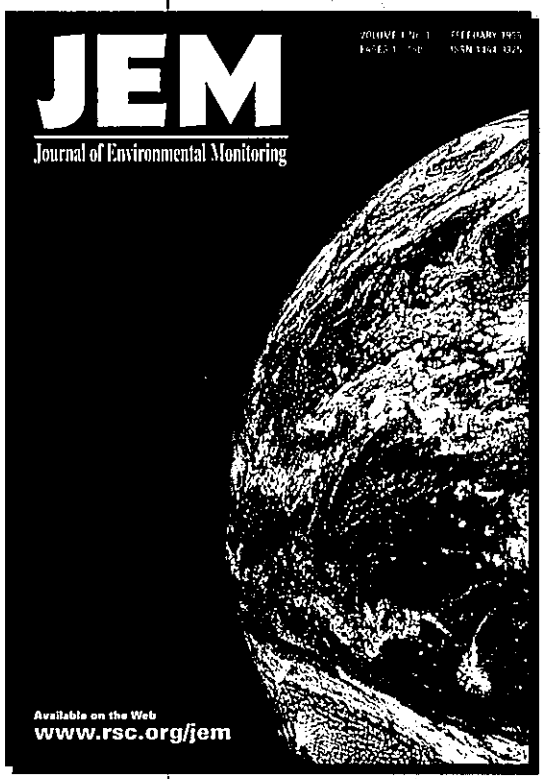

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