



International Association of Hydrogeologists

AUSTRALIAN NATIONAL CHAPTER

NEWSLETTER

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APRIL 1991

STATE NEWS

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NEWS FROM THE CENTRE FOR GROUNDWATER MANAGEMENT AND HYDROGEOLOGY

The Centre was established in July 1987 at the University of NSW (UNSW) and has grown to 10 staff with 8 supported entirely on non-university funds. The staff engage in research, training and consultancy and operate within an annual budget of about \$1 million. Some 39 research projects are grouped under 8 programs:

- Borehole performance deterioration
- Salinity
- Botany Sands aquifer and wetland interactions
- Mine water problems
- Modelling, pump test evaluation and fractured rock hydraulics
- Waste disposal and groundwater
- General hydrogeology
- Contaminated sites

A strong research emphasis is being placed on geophysical techniques in a number of programs.

Sixteen projects have been completed since 1987 and productivity indices for the period 1989 - 1991 (April) include:

- 40 Research publications
- 23 Contract Research Documents
- 11 Theses (Masters etc) completed

A list of publications can be provided on request.

The new Master of Applied Science Degree in Hydrogeology and Groundwater Management which began in 1989 is being received well with 6 graduates to April, 1991. Numerous other candidates are at various stages of part-time degrees.

Demand for the Masters training is rising especially from overseas as the Degree gains international recognition. Even Canadians are indicating a preference for UNSW rather than Waterloo! All graduates to date have been snapped up prior to graduation or soon after in spite of the recession.

The Centre has been developing international linkages in recent times with two campus' of the University of California:

- Lawrence Berkeley Laboratory (LBL) (Berkeley, San Francisco)
- UCLA (Los Angeles) - Civil Engineering

Four Centre members visited LBL and UCLA last September to begin developing a co-operative research program (fractured rock hydraulics) and a regular Research Seminar exchange (site remediation and wastewater treatment). In 1992 the UCLA team is planning to pay a return visit to Sydney for a Research Seminar on site remediation; water quality policy and waste water treatment. These exchanges have been supported by the Department of Industry Technology and Commerce. (DITAC) (USA- Australia Bilateral Agreement) and under the UNSW - University of California Agreement.

A current major change that is having a bearing on research and training, is the interfacing of the Centre's activities with those of the new Co-operative Research Centre (CRC) in Waste Management and Pollution Control. The Groundwater Centre played an active role in the successful submission (one of 15) which was awarded by the Federal Government in March 1991. The CRC is a large (\$7 million annual budget) venture that will be run on very commercial lines. We along with the many many partners plan to carry out substantial research programs on waste which in our case involves problems linked with groundwater.

The Centre is gaining increasing acceptance in the consultancy market place. We act both as principal consultant and as sub-contractors. Most tasks chosen include a major research component and often lead to publications. One large recent task was the impact of Sydney's proposed third runway on groundwater in the Botany Sands aquifer and associated wetlands. Numerous projects also relate to groundwater and land contaminated by organic chemicals with the largest of these associated with the ICI chemical factory at Botany.

Should any reader wish to have further details about the Centre activities please contact:

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FROM THE PRESIDENT

Water quality policy issues are dominating groundwater and surface water thinking both at national and State levels. We are all awaiting eagerly the AWRC guidelines!! The New South Wales State Pollution Control Commission (EPA after July 91) is currently formulating new water quality legislation having gone through a period of public comment on position papers. Water use in the long and short term in relation to quality standards and who should decide are pivotal to discussions.

A seminar on the matter was recently arranged by the Australian Water and Waste Water Association and was well attended. A good debate occurred but a strong groundwater viewpoint was not expressed. I urge all groundwater professionals to speak up as they have opportunity to make sure groundwater aspects of water quality policy are properly taken into account. Different states are following through on this issue at different rates. Fuelling the moves for change in water quality policy is the rising environmental pressure in the community. One very positive aspect is that this is the creation of substantial employment for hydrogeologists at a time of recession when traditional servicing areas such as rural water supplies and the mining sector are cutting back.

Looking ahead it appears reasonable to suggest that many of us will need to continue growing in knowledge of groundwater chemistry especially in the pollution area, if we are to be competently able to describe and rehabilitate contaminated groundwater. It is with these points in mind that the Centre for Groundwater Management and Hydrogeology has arranged an advanced Short Course on Organic Chemical Contaminants in Groundwater (see details elsewhere in Newsletter). Through our contact with staff at a number of research institutions in the USA it has been possible to bring out experts on practical evaluation of organics contaminants, and their remediation and modelling. The course will draw together a balance of researchers and practitioners with the goal of advancing this most difficult field.

As this article is written extensive areas of NSW and Victoria are suffering serious to severe rainfall deficiencies in 1991. This repetitive pattern of drought following flooding rains strongly suggests that groundwater resource hydrogeologists will continue to be in demand albeit in a variable number and in different locations. The 11th AWRC Groundwater School in July (see advertisement) will help provide concentrated training in resource hydrogeology. It could be very timely if the drought continues.

I trust that you find this Newsletter helpful and informative. Please do not hesitate to write articles, view points, letters to the editor. We would be most happy to receive your view points and endeavour to pass them on to IAH members in an appropriate manner.



CENTRE FOR GROUNDWATER MANAGEMENT AND HYDROGEOLOGY UNIVERSITY OF NEW SOUTH WALES

11TH AWRC GROUNDWATER SCHOOL

Hydrogeology Groundwater Engineering Management 14—19 July, 1991

This course is for those wishing to expand their engineering understanding of chemical and physical properties of groundwater, its occurrence and interaction with surface water.



Topics include:

- Successful exploration methods
- Aquifer evaluation, hydraulics
- Extraction techniques, dewatering
- Borefield management (modelling)
- Salinity and pollution
- Fieldwork (pump test, hydrochemical measurement, geophysical techniques)
- Problem solving tutorials

Course Leaders: Team of experts from Groundwater and Drilling Industry and leading researchers.

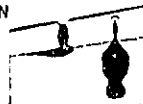
Course Fee: \$1000

Both courses meet the requirement of the 1% Training Guarantee Levy and are accredited by the Institution of Engineers (Australia)

ORGANIC CHEMICAL CONTAMINANTS IN GROUNDWATER 22—26 July, 1991.

This course will study the behaviour in groundwater and soil of commonly contaminating chemicals such as:

Hydrocarbons (petrol, oil etc), Organochlorines (eg solvents), PCB's, Pesticides, Phenols etc. The aim of the course is to impart to the user, practical skills for investigation and remediation.



Topics include:

- Occurrence and properties of organics
- Chemical and microbiological behaviour
- Sub surface flow
- Site investigation (geophysics, gas sensing, drilling, sampling, safety)
- Chemical analysis
- Modelling
- Remediation, risk and regulatory issues
- Field and laboratory demonstrations of new techniques and methods

Course Leaders: Team of international and Australian experts, leading researchers, consultants and practitioners

Course Fee: \$1200

FOR MORE INFORMATION CONTACT

MOLLIE LENTHALL — PHONE (02) 697 3175 FAX (02) 662 6983

NATIONAL COMMITTEE NEWS

Treasurer's Report

The 1990 Statement of Income and Expenditure (at 31.12.90) for the Australian National Chapter of IAH, shows the Association's finances are in a reasonable position and improved from the 1989 position. A surplus of \$8148.38 was achieved, thanks to the efforts of the previous National Executive and particularly Phil Commander.

Finances were inflated at the end of December because the accounts contained the bulk of member's 1990 subscriptions. An amount of \$7777 (DM 9350) was remitted to Germany at the end of March 1991 at an exchange rate of DM 1.20. The exchange rate has been low for some time, and is down substantially on the previous year's rates that reached a high of DM 1.49. At the time of sending the annual subscriptions to Germany, the Australian Chapter had:

- * 184 fully paid up members for 1990 and 1991
- * 24 members in arrears for 1 year
- * 7 members in arrears for more than 1 year

Apart from the overseas subscriptions, there are also a number of outstanding commitments (Newsletter costs, 1990 Perth Conference Proceedings) that will reduce the Association's funds for 1991.

New Members

Since the new National Executive took over in August last year, there has been a substantial increase in new members thanks to the efforts of all State Groups. The following new members are welcomed:

Dr G Pantelis (NSW)	Mr G Richards (WA)
Mr R Brodie (ACT)	Mr G Hawkes (WA)
Dr W Poplawski (QLD)	Mr M Robinson (VIC)
Dr J Bauld (ACT)	Mr G Willgoose (NSW)
Ms L Lytton (NSW)	Mr N Robertson (WA)
Ms L Shoebridge (VIC)	Mr D Scott (NSW)
Mr R Sanders (NT)	Dr W Milne-Home (NSW)
Ms U Zaar (NT)	Ms P Kevin (VIC)
Mr T Schwartz (NT)	Mr C Day (VIC)
Mr P Rowston (NT)	Mr D Strudwick (VIC)
Mr K Martin (NT)	Ms S Ryan (VIC)
Mr K Lucas (QLD)	Mr C Basocak (VIC)
Dr J Jiwan (NSW)	Mr I Callow (QLD)

Membership now totals 215 (current financial members plus those in arrears for 1989 and 1990). The State distribution is WA(71), VIC(43), NSW(42), QLD(24), NT(14), SA(14), ACT(5), TAS(0), and OVERSEAS(5). There are currently 254 people on the National Committee's Newsletter circulation list.

STATEMENT OF INCOME AND EXPENDITURE FOR YEAR ENDED 31.12.90
(SUBSCRIPTION YEAR 1990)

DOLLARS (\$)

INCOME

Membership Subscriptions		
1986 (in arrears)	- 1	55.00
1987 (in arrears)	- 1	55.00
1988 (in arrears)	- 6	330.00
1989 (in arrears)	- 18	948.00
1990	- 129	7085.00
1991 (in advance)	- 2	110.00
1991 (new members)	- 18	990.00
Sale of IAH Ties		37.00
Bank Interest		
Savings Account		614.51
Term Deposit		508.36
Savings Investment Account		244.59

TOTAL INCOME \$ 10977.46

LESS EXPENDITURE

Remittance of Subscriptions to Germany	1415.78
Reimbursement of Overpayments	10.00
IAH Newsletter Production	135.00
AWWA Journal to Members	360.00
Postage	210.77
Envelopes, Paper and Sundries	38.99
1994 IAH Congress (Adelaide) Expenses	647.20
Government Charges	11.34

TOTAL EXPENSES \$ 2829.08


NET SURPLUS (LOSS) FOR THE YEAR 8148.38
Add BALANCE FROM LAST YEAR 7062.79

ACCUMULATED FUNDS ON HAND (as at 31.12.90) \$ 15211.17

Represented by -

Cash at Bank - Savings Investment Account	13534.99
Cheque Account	1676.18

TOTAL \$ 15211.17


Honorary Treasurer

10th April 1991
Date

Auditor's Report

I have examined the Statement of Income and Expenditure for the year ended 31 December, 1990. In my opinion, these financial statements are in agreement with the books and records maintained by the IAH - Australian Chapter.


Honorary Auditor

12 April 1991
Date

Members in Arrears

The following members are in arrears for the years shown. The treasurer would appreciate it if fees (\$55 for each year) could be forwarded as soon as possible .

In arrears for 1990 -

Bleys, Boyd, Briese, Brinkley, Davidson, Grounds, Hailu, Hair, Hall, Helm, Jacobson, Jasmer, Johnson (M), Karp, Leach, Lloyd, Macumber, McLaughlin, Page, Please, Ticknell, Townley, Tuckson, Walker.

In arrears since 1989 -

Bell, Dyson, Harwood, Love, Preston, Punthakey, Rowan.

IAH membership rules state that memberships in arrears for more than two years will lapse. Hence these members who have not paid since 1987 are deemed to have resigned -

Dobie, Harris (B), Holland, Hurle, Johnson (C), Milne, Murphy, Roberts, Speedy, Youngman.

Address Changes

Please send any changes of address to the Treasurer to ensure correct delivery of mail. We will update our distribution list and promptly pass the changes onto the International Secretariat.

1991 Subscriptions

Given the lower foreign exchange rates, falling interest rates, and increasing Newsletter and distribution costs, the National Committee has been forced to increase the Australian membership subscription for 1991 to \$60. Most members will agree this is only a modest increase, given that fees have been maintained at \$55 for a number of years. Those few members who paid their 1991 subs prior to March 1991 (at the old rate of \$55) will not have to pay the increase.

To keep invoice costs down, members are requested to send their 1991 membership fees (\$60) to the Treasurer by the 28th JUNE 1991. My address is :

IAH Treasurer
c/- Hydrogeology Unit
Dept of Water Resources
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Overseas Members List

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WA BRANCH MEETINGS

24 October 1990

Mike Sklash, Associate Prof., Dept. of Geology, University of Windsor, Ontario, temporarily with CSIRO.

'Use of Natural Tracers for assessing contamination potential' - described the use of environmental isotopes in a glacial terrain with concealed, highly permeable esters.

18 November 1990

John Waterhouse, ACG - Woodward Clyde - described groundwater conditions in Baluchistan, with beautiful slides of snow capped peaks and of the canal systems.

30 January 1990

Phil Commander (GSWA), George Domahidy (Rockwater), Bob McGowan (GRC - Dames & Moore).

'Hydrogeological Mapping Practices' - each speaker outlined aspects of a hydrogeological map sheet he had worked on.

5 March 1990

Wolfgang Kinzelbach, Professor, Dept. of Hydraulics and Engineering Hydrology, Kassel University, Germany. 'Determination of catchment areas of groundwater abstraction wells in 'contaminated' aquifers - gave a very thought-provoking presentation on determination of groundwater capture zones, illustrated by examples from Germany.

WA MINES DEPARTMENT DRILLING BRANCH CEASES OPERATIONS

The effects of WA Inc were felt across most State Government Departments in the wake of the September 1990 budget. The Mines Department chose to completely close down the Drilling Branch in order to balance its books. Drilling activities ceased abruptly leaving projects incomplete. Staff have been redeployed and equipment is to be sold off. Over the past thirty-three years the Drilling Branch had carried out groundwater exploration for the WA Geological Survey and had the capacity to drill bores to a depth of 1800m.

The WA Branch of IAH made a submission to Ministers and an Opposition spokesman on the ceasing of drilling, pointing out the importance of continuing groundwater exploration to the development and economy of the State.

Projected funding of \$1.2M for the next year will be half the previous level, with work to be carried out by drilling contractors.

PIPELINE MANIA IN THE WEST

Western Australia has once again been in the grip of pipeline mania, with Water Resources Minister Ernie Bridge's 2 500 km Kimberley-Perth water supply pipeline scheme gaining a lot of media publicity and support (*West Australian*, March 2, 9, 14, 18). Premier Carmen Lawrence announced on 13 March 1991 the expenditure of \$50 000 to investigate funding options for the \$8 billion scheme. She said 'we have serious water problems in Perth and will be facing water shortages just after the turn of the century The underground water supply isn't going to be sufficient.'

A different story, confirming previous Water Authority reports, was reported soon after from the AWWA conference (*West Australian*, March 20, 22); a Binnie and Partners report concluded that WA's south west could supply cheap water to Perth and the southern half of the State well into the 21st century, taking into account climate change and growing demand. The cost of south west water was estimated to be 60c a kilolitre compared with \$3.50 a kilolitre from the Ord.

WA PROVISIONAL CALENDAR

27 March 1991

Dewatering of Underground Lead-Zinc Mines in the Kimberleys.
Mr Andrew Bailey, BHP-UTAH Minerals International.

29 April 1991

Nutrient Loss from Catchments and Enrichment of Wetlands in South West of WA.
Mr Bob Humphries, Environmental Protection Authority.

27 May 1991

Overview of Agricultural Salinity Problems in South West of WA.
Dr Don McFarlane, Department of Agriculture.

26 June 1991

Annual General Meeting. Bioremediation: Feasibility and Field Scale.
Mr Terri Bulman, Campbell Environmental Ltd.

QUEENSLAND BRANCH ACTIVITIES

Since our last Queensland report in the June newsletter last year, meetings have been held at about two monthly intervals, with attendances ranging from 10 to 15 members, with many other interested people attending from time to time, depending on the topic being presented.

At the September meeting, Dr Des Connell, Dr Ross Sadler and Glen Shaw from the Government Chemical Laboratory spoke on interesting chemical topics relating to groundwater.

Don Rea from SANDVIK-MISSION presented information about the TUBEX system of drilling at the November meeting.

On 12th December a Christmas barbeque was held for IAH members and staff of the Water Resources Commission Groundwater Hydrology Section at the residence of the Chairman, Mr John Hillier. Over 40 people attended and the evening was enjoyed by all.

At the first meeting for 1991, Julie Iveson from the Research and Development Laboratory of Ampol Petroleum Qld Pty Ltd spoke on Inorganic Water Chemistry.

The next meeting to be held in April will be our AGM where new office bearers will be elected for this year.

N.S.W. REPORT

Government View

The Department of Water Resources (DWR) has an ambitious program to review all its groundwater quality networks by 1992. The existing scatter gun approach to collecting groundwater quality information will be replaced by a methodology involving long term data, issues related data and project data. A report on methodology (TS 90.062) is available.

Hydrogeological mapping is continuing with the Narrandera 1:250,000 sheet nearing completion and the Hay 1:250,000 sheet underway. The Darling Basin map has been re-scheduled for completion in 1993.

Work is continuing on Dryland Salinity projects. Management plans are being prepared for Kyeamba Creek (Wagga Wagga) and Goran Basin (Gunnedah). Both areas are badly affected by rising groundwater levels and associated water logging and salinity problems.

Work has begun on a State Groundwater Protection Policy. This program will require some inter-agency co-operation in order to achieve a uniform approach to groundwater pollution.

Field studies have commenced to assess the location and rate of saline inflows to the Darling River.

A study of the Wakool/Tullakool wellfield has been completed to enable pumping schedules to be optimised so that costs can be minimised for this watertable control scheme.

Consultants View

The recession has slowed down consulting work considerably. The only sector to maintain a moderately high profile is environmental work.

Several consulting groups are changing their staffing mix to accommodate work such as site assessment, water treatment and waste water management.

Off shore work continues to be attractive in the Asia-Pacific region for companies with geotechnical and hydrogeology strengths.

NITRATE IN GROUNDWATER: AN AUSTRALIAN PROBLEM AND AN INTERNATIONAL WORKSHOP

Causes

European man's activities in Australia have had a profound impact on groundwater and the environment. In parts of southern Australia we are all too familiar with dryland salinity, waterlogging and increased stream salinity caused by man-induced increases in groundwater recharge rates. We also observe expanding areas where nitrate concentrations in groundwater are climbing over internationally accepted drinking water guidelines. In arid areas the causes of high nitrate groundwater have existed since the dreamtime. However in temperate areas modern agriculture and intensive habitation contribute to the degradation of our groundwater resources. We seem to follow all too faithfully the patterns of Europe and the US corn belt.

The intensity of agriculture is assisted by increased use of nitrogenous fertilisers and the rapid growth of new intensive livestock industries. The nutrient turnover in these systems is significantly higher than for unimproved land. The level of expertise to manage such systems needs to be higher than ever before if economic development and groundwater protection are to be achieved concurrently. Significant investments to develop this expertise are being made in some parts of the world. For example, integrated water and nitrogen management practices in corn growing areas are part of the US President's water quality initiative, a multimillion dollar program with the joint goals of improving groundwater quality with no decline in agricultural productivity.

Unlike phosphorus, and many species of bacteria which are readily adsorbed on soil particles, nitrogen in the form of nitrate is as mobile as groundwater. Therefore high nitrate concentrations serve as the first warning of impending environmental problems. These may be associated with point sources such as dairies or piggeries, or diffuse sources such as fertilised crops and pastures.

In many studies nitrate has been used as the sole indicator of pollution. This can be misleading when dealing with sources which are rich in organic nitrogen. This was shown in a study conducted by Stuart Richardson, while an M.Sc. student of the Centre for Groundwater Studies. He found that wastes from a former cheese factory and abattoir, 13 years after disposal into groundwater ceased, formed a plume with an anoxic core. In this the most polluted part of the aquifer, where total nitrogen concentrations were highest, there was no nitrate. In many cases contamination is most intense in the upper part of unconfined aquifers. Sampling strategies need to account for this stratification.

Consequences

In coastal estuaries, nitrogen is often the limiting nutrient which may prevent or trigger algal blooms. This has become of major concern in Greece, Turkey and Denmark where increasing nitrogen loads carried by streams have produced eutrophic estuaries.

Aside from environmental concerns, is nitrate in drinking water really a health problem? There had been speculation that drinking water guidelines for nitrate concentration may change (upwards and downwards). Any change would influence the need for controls on sources of nitrate, and the demand for new water treatment technologies. With this in mind a recent international workshop involving forty-eight invited participants had the potential of being a watershed for groundwater management and nitrate research, not only in Australia.

At the NATO Advanced Research Workshop on Nitrate Contamination: Exposure, Consequence and Control, in Nebraska September 1990, the health effects of nitrate consumption were discussed by pathologists, toxicologists and epidemiologists. This group concluded that the current guidelines 10 mg $\text{NO}_3\text{-N/l}$ (USA) and 50 mg $\text{NO}_3\text{/l}$ (EEC) need not be lowered. In infants no adverse health effects apart from methaemoglobinaemia are observed with water concentrations less than 100 to 150 mg $\text{NO}_3\text{/l}$. Above this level there is epidemiological evidence for increased incidence of Non Hodgkins Lymphoma.

Gastric cancer studies of all kinds have not been able to demonstrate a clear link between low nitrate concentrations in water and gastric cancers. Nor have they been able to establish that there is no link. The complicating factors include a significant nitrate intake in food, the only recently appreciated ability of the human body to endogenously produce nitrate, and the variation in microflora colonies between individuals which are capable of converting nitrate to nitrite and subsequently to nitrosoamines and amides. It is only the latter which are known to be carcinogenic.

Studies involving a synthetic non-carcinogenic amine nitrosoproline, have shown significant differences in an individual's ability to generate nitrosoamines. People with non-acidic stomachs are the most susceptible sub-population. There is a difference between nitrate ingested in vegetables (which is accompanied by vitamin C, an inhibitor of nitrosamines) and nitrate in drinking water. There was a convergence of opinion that we cannot prove that nitrate concentrations in drinking water between 50 and 100 mg NO₃/l have no effect on cancer rates, but that any risks which were avoidable should be avoided. Therefore, there is no scientific reason to raise or lower the current drinking water standards.

Control

The control sessions of the NATO workshop focused on water treatment technologies. Biodenitrification plants appear to be most effective with selective ion exchange and electro-dialysis techniques competitive for less contaminated waters. UK, France, Germany and the Netherlands were opting for water treatment, as a short-term measure to improve quality, and for land management as a long-term measure to reduce environmental threats. European investment in groundwater treatment plants solely for nitrate removal currently exceeds A\$15M p.a. Natural controls such as denitrification occurring in riparian zones and in anoxic layers in aquifers were also noted. Stimulation of in-situ denitrification in aquifers is in a research stage.

After considering causes, consequences and control, consequences are still the biggest unknown. However, we know enough to set priorities and rank NO₃ risks alongside other water quality risks. Good management of sources is preferred to treatment of water supplies, and often treatment is seen as an interim measure to give improved land management time to affect groundwater quality.

This was a timely workshop and thanks to brilliant organisation which also enabled non-NATO countries (including New Zealand and Australia) to be represented, it has set the direction for nitrate research and land-groundwater care in temperate agricultural areas for the next few years.

Peter Dillon
Director CGS

25TH IAH CONGRESS/AWRC GROUNDWATER CONFERENCE Management to Sustain Shallow Groundwater Systems

Dr Knight reported in the last newsletter that the Australian Chapter of IAH has been successful in its bid to host the 25th IAH Congress to be held in Adelaide 5-9 September 1994. The organising committee is fired up and has generated some novel ideas to make the conference appealing to all Australians working in this field, as well as attracting as many overseas guests as possible. These ideas will gradually unfold. We need some help from members in each State and Territory in developing pre- or post-conference tours, ideally involving groundwater at places that overseas visitors will find appealing. Steve Barnett (ph 08 2747583) is collecting ideas and offers of help. Peter Smith (ph 08 2747691), leader of the publicity group, is interested to hear of opportunities we could use to raise awareness of the Congress, particularly overseas. Any members travelling overseas to relevant conferences are welcome to borrow a video promoting this Congress and to take fliers to distribute.

The committee is tireless and with your support this promises to be a memorable Congress!

Peter Dillon
For Organising Committee

WORKSHOP ON GROUNDWATER CONTAMINATION : MODELLING AND CLEAN-UP

For five days in February Professor Wolfgang Kinzelbach of Kassel University, Germany gave the 37 attendees of this CGS workshop everything and more than they could have asked for from a workshop leader. He covered the theory and application of solute transport models, coupling of hydrochemical and solute transport models, and principles and practice of clean-up of contaminated groundwater. In addition to the copious lecture materials he also provided software to participants, and when the need arose even asked questions in Chinese.

Dr Chris Barber and Dr Greg Davis, CSIRO Division of Water Resources, contributed a detailed case study of migration and detection of volatile compounds in groundwater systems and studies of sampling procedures and the use of surface geophysics to detect pollutant plumes from landfills. A number of participants presented case studies involving nitrate contamination, landfill studies, and modelling of contaminant transport. A learning exchange was also held one evening on groundwater and solute transport models. Getting together can shorten learning curves for us all and the workshop has accelerated the adoption and better use of contaminant transport models and clean-up approaches.

Spare copies of the first two volumes of workshop notes: background papers and software guide are available at \$60 a set from Joseph Mazzone (ph 08 274 9212), and Prof Kinzelbach's package of models is also available at a modest price.

Peter Dillon
Director, CGS