International Association of Hydrogeologists
AUSTRALIAN NATIONAL CHAPTER

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NEWSLETTER

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The following speech was made on the election of Professor Michael J Knight to the position of World Presidency of IAH at the General Assembly of IAH held in Beijing on 7 August 1996.

BUILDING TO THE FUTURE

IAH PRESIDENTIAL SPEECH

by

Professor Michael J Knight

National Centre for Groundwater Management
University of Technology, Sydney
Broadway, New South Wales, 2007, Australia

IAH General Assembly, Beijing , China

7th August, 1996

I want to begin by thanking all those who have supported my nomination for the Presidency of IAH. This support extends beyond us here tonight out to our colleagues in many countries around the world. Placing a person into such a position of responsibility involves considerable trust and a step of faith and I pledge that to the best of my endeavours I will lead IAH in a manner that shows the trust is well founded.

Anything we do we do on the shoulders of others. We cannot build a sustainable work without a strong foundation. We have such a base. The great growth over the past four years both in numerical membership and professional standing of IAH has to a considerable degree been due to the insightful leadership of John Moore, President, Andrew Skinner, Secretary General, Wilhelm Struckmeier, Treasurer and the Council. They have spent many long hours in sacrificial unpaid service helping us to develop professionally, so that we can better serve our communities.

They in turn built on the rich heritage of past Councils and members who had a vision to see IAH progress and develop. We formally date back to 1956 when Professor Fourmarier from Belgium became the first President at the IGC meeting in Mexico City. Some ten other Presidents have held office since that time. They have been ably supported by five Secretaries General and six Treasurers.

We now have a strong group with over 3,000 members with national groups on all continents but not all countries. Annual congresses are well attended and achieve a high standard. IAH publications are highly sought after and are valuable tools for members. Our seven Commissions and six other Working Groups provide an opportunity for specialised study of particular facets of Hydrogeology such as Karst, Mineral and Thermal waters and Hydrogeology of Urban areas.

So that's where we have come from, *but* where are we now. What is our vision for the future. Building to the future in IAH is going to involve, I believe, three essential elements;

- The *first* is encouragement and professional support of each other.

- *Secondly* we in each of our nations need to identify the key and relevant groundwater issues and address them in a prioritised manner.

- The *third element* is the need to communicate the importance of groundwater to our communities and Governments.

Professional support and encouragement currently takes place in National Groups. An illustration of success on a national level is here at this congress where we see the great service, dedication and skill of our colleagues in China who have made it possible for us to be here. Thank you Professor Fei Jin and your many helpers - we appreciate it.

It is an interesting observation that in most countries it is often a dedicated few individuals that put in the creative effort to serve our profession. I believe each of us, as individuals, can make a significant contribution if we are motivated and catch the vision of possibilities. It is individuals that are going to achieve things within some co-operative grouping. IAH is now perhaps at a stage where we need to also consider ourselves as part of a *region* that is probably defined by some common general heritage, cultural linkage etc. These main regions could be; Europe, Asia, Australasia and the Pacific, North America, South America and Africa.

One goal of my Presidency will be to identify, and encourage key leaders in each Region to help achieve the goals of growth and sustainability. This could include regional activities such as conferences, membership growth and the birth of new National Groups. Some regions are set for exciting internal growth with the potential for new National Groups such as in Asia and Africa.

We also need to recognise that some regions are stronger than others and *Region to Region* assistance could be mutually beneficial. Encouragement and support of further IAH development in Africa is important not only for the profession but also the community at large, given the regular water crises faced in many African countries. It's too much to expect the few IAH leaders in Africa to do it all. John Moore has begun this process by his recent most successful trip to a number of Southern African countries. Let's build on this foundation.

Turning to groundwater issues; at one level the challenges we face as we move towards the Year 2000 and beyond are relatively simple; enough water of the right quality geared to particular needs or uses. But as we all know that to achieve this is becoming increasingly more technically complex, multi-disciplinary and often politically hard to achieve. Conflicts can arise choices may occur between industrial development, employment and water degradation. We are going to need to develop closer relationships with, and understanding of industry. Positive, creative solutions are required rather than criticism from a distance.

Growing urban development, worldwide is putting increasing pressure on the need for right management of water quality and quantity. By the Year 2000 more than 3.2 billion people (50%) of the world's population will be urban dwellers. The theme of Urban Groundwater at our IAH Congress in Nottingham next year and the growing activity of The Commission of Hydrogeology in Urban Areas under the leadership of David Lerner

and his colleagues show that we are taking this matter seriously. I predict that such urban water problems will become of increasing importance to all of us.

As we grow technically we will always need to achieve a balance between developing the basic, classical side of hydrogeology such as resource understanding along with tackling applied problems and being relevant in a rapidly changing world. An example of this new approach is the application of groundwater flow, chemistry and microbiology to the production of sustainable and environmentally compatible land-based waste treatment systems.
Traditionally we have stayed at a distance and seen waste disposal in a negative light; a polluter of groundwater. It is time we changed this viewpoint and became constructive participants. Each country needs to actively identify its groundwater priorities and focus on those.

Finally we need to think of creative ways of sharing the excitement and interest we have in groundwater with our communities. This communication is by its nature, culturally bound and has to be substantially promoted at a National level. Our IAH Journal and other special publications play an important role in communication between each other at a technical level but we each need to work out how to translate this information so that the public at large can appreciate the value of groundwater. This is especially so at a political or other decision making level.

In closing, I see my role over the next four years as an encourager, facilitator where appropriate with the goal of actively expanding the depth of leadership in IAH. IAH, cannot progress and grow to meet the challenges ahead unless we all recognise the part we have to play.

Remember **"Success in never final,**
Failure is never fatal,
It is courage that counts"

Winston Churchill

Editor

There will be one more newsletter this year, to come out in mid-November. Deadline is

Friday, 1 November, 1996

The best way to send Newsletter items is direct to the editor, either by email (which I can extract and reformat), or mail it in a camera-ready form of A4 size (which will be reduced to A5). Don't need bromides, just a good clear copy. To:

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IAH - AUSTRALIA PRESIDENT'S PAGE

For this issue, the President has decided to "pass the parcel" and requested that I pen a few words for this newsletter.

The main item of interest to hydrogeologists at present is the forthcoming "Mesozoic 96" conference to be held in Brisbane over the period 23 to 26 September 1996. The conference will be hosted by the Geological Society of Australia (Queensland Division).

Two full conference sessions on 26 September will be devoted to hydrogeological matters. The program for these sessions has been arranged by IAH (Queensland) and will cover the topic "Hydrogeology of Mesozoic Basins". Papers to be presented at the conference include:

- The Great Artesian Basin - Management of Water Resources after 100 Years of Development. **Mr John Hillier (DNR & President IAH).**
- Development and Operation of Water Supply Borefields for Olympic Dam Operations. **Mr Keith Berry (Western Mining Corporation).**
- Cretaceous Aquifers in the Northern Territory. **Mr Geoff Prowse, Mr Des Yin Foo and Mr Peter Jolly (PAWA).**
- The Mesozoic Groundwater of Cape York Peninsula. **Mr Tony Horn (DNR).**
- Groundwater Chemistry of the Great Artesian Basin, Australia. **Dr Rein Habermehl (AGSO).**
- Fluoride Anomalies in Aquifers of the Queensland Section of the Great Artesian Basin and Their Significance. **Mr Peter Evans (DoE).**
- An Outline of Palaeoformation Water Compositions and Flow Patterns in the Eromanga and Cooper Basins Through Time. **Dr Peter Eadington.**

Other topics to be covered at the conference include: Mesozoic Tectonics, Coal & Petroleum Resources, Industrial Minerals & Metals, Gemstones, and Gold Resources.

A Trade Exhibition is planned as part of the conference program. Organisers are expecting a good representation from the Mining Industry, Government Departments, Academic Institutions and Consultants. It promises to be an interesting conference, and IAH encourages its members to attend.

Iain Hair
Vice-President IAH-Australia.

REPORTS FROM IAH BRANCHES

AUSTRALIAN CAPITAL TERRITORY

August 1996

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

As part of the reduction of the Commonwealth Public Service by the Federal Government, the Australian Geological Survey Organisation (AGSO), which is part of the Commonwealth Department of Primary Industries and Energy, and is Australia's premier geoscientific organisation, is experiencing a large change.
AGSO is going through a tumultuous and stressful period during the period May to August 1996 with the announcement that AGSO's budget and staff would be reduced by about 24 percent.
AGSO's budget cut means a reduction of its budget as follows:

1995/96	-	$ 55.4 million
1996/97	-	$ 48.7 million
1997/98	-	$ 37.8 million
1998/99	-	$ 38.2 million

AGSO's staff of 550 is being reduced by about 142, with a large number of programs being affected, and a large number of projects being abolished.
Staff in affected areas have been offered voluntary retrenchment on 12 August 1996.

AGSO is also being restructured, with a focus on the following key areas - Minerals, Petroleum, Australian Ocean Territory, Land and Water, Geohazards and Corporate Support.

The changes to AGSO's structure and the identification of areas for staff reductions are a response to a serious budgetary problem. All of the above are being implemented prior to the Commonwealth Government Budget on 20 August 1996, which could still require additional adjustments.

VICTORIAN BRANCH

1998 Groundwater Conference

The Victorian Committee (headed by Charles Lawrence) is feverishly working away organising the 1998 IAH International Groundwater Conference in Melbourne. This, as I am sure you know, is a major undertaking and makes the Sydney 2000 Olympics look like a Sunday School picnic. You will hear much more in the next year.

Meetings

April 1996 Contamination Transport
June 1996 Surface Mine Reclamation

The Way Things Happen in Victoria

Under the privatised model for hydrogeological services in Victoria, the Department of Natural Resources & Environment has let a number of consultancies for Groundwater Resource Assessments. The majority of work is undertaken by Sinclair Knight Merz with D J Douglas, Roger Blake and CMPS&F also undertaking specific projects.

Strategic Review

Perhaps the most significant project underway in Victoria is a long term investment analysis. This project aims to define all groundwater investigations, monitoring and research activities for the next 100 years, as well as all management requirements (in terms of statewide management, retail (i.e. local) management, and numerous other tasks). All these activities are then costed on an annual basis and the economic value of undertaking all these tasks is ascertained in relation to the value of the groundwater. The ultimate outcome of the project is to provide a rational basis for determining an appropriate level of groundwater charges and also, who should pay for what.

Hydrogeological Mapping

Hydrogeological Mapping for Victoria continues with the recent release of the 1:250,000 scale Warragul/Sale Hydrogeological Map.

QUEENSLAND BRANCH

ARTESIAN BORE PIPING SCHEME

The Kaywanna Bore Water Piping Scheme, 80 kilometres north of Goondiwindi was opened on 1st August, 1996, by the Honourable Howard Hobbs, Minister for Natural Resources.

John Hillier (President of IAH-Australia) in his official role with the Department of Natural Resources, Queensland, attended the opening. He spoke about the hydrogeology of the Great Artesian Basin, the benefits of the rehabilitation project, in particular, the Kaywanna project, and the role undertaken by the GAB Interstate Working Group in co ordinating the project.

AGSO PRESENTATION AT QUEENSLAND DEPT NATURAL RESOURCES, ON GROUNDWATER QUALITY ASSESSMENT IN THE LOGAN-ALBERT CATCHMENT, SE QUEENSLAND

On 9 July 1996 John Bauld and Patty Please presented a summary of the groundwater quality work that AGSO undertook in the Logan-Albert Catchment, SE Queensland during 1994. The presentation summarised a draft report entitled "Groundwater Quality of the Logan-Albert Catchment" by PM Please, KL Watkins and J Bauld. It was attended by scientists from various departments of QDNR and faculty and postgraduate students from QUT.

John Bauld started the presentation with a review of AGSO's Groundwater Quality Assessment Project which involves 10 catchments nationwide. The main objectives of the Program are to:
establish benchmark/baseline conditions in key groundwater resource areas;
monitor for subsequent trends in quality indicators;
identify and understand processes impacting on groundwater quality; and
integrate information and provide advice to natural resource managers.

Patty Please continued the presentation with discussion of the Logan-Albert work beginning with an introduction to the area that included the geology, landuse, hydrogeology, site selection and previous work. Samples were recovered from 36 QDNR observation bores situated in the Quaternary alluvial aquifer which is overlain by a thick confining/semi-confining layer. Landuse of the mid-sector of the catchment, where all the sampling was done, is principally rural and is dominated by beef and dairy production. The core of the presentation covered interpretation of the groundwater quality data including field data, major and minor ions, metals, nutrients, pesticides, faecal indicator bacteria and environmental isotopes (the pesticide and microbiological contaminants were discussed by John Bauld).

Interpretation of the data focussed on three areas: (a) groundwater characterisation, (b) contamination, and (c) processes. The data represent the situation in June/July 1994 during a severe period of drought. Some of the key results were:

* Regional groundwater flow is in a northerly direction with an associated increase in TDS. The groundwater appears to evolve from a mixed cation-bicarbonate type water to a mixed cation-chloride type water.

* Modern recharge is evident in the southern sector of the Albert and Teviot Brook catchments

* The water is much older to the north. Recharge in this sector is either very slow through the unsaturated zone or via discharge from the underlying Jurassic aquifer.

* Hydraulic data indicates a connection between the aquifer and local rivers but the chemical data does not demonstrate a mixing of the two waters.

* Nutrient and pesticide contamination was not detected. However, the presence of long-lived faecal indicators in 22% of groundwater samples suggests that the aquifer may be vulnerable to persistent contaminants delivered via preferential pathways through the "confining layer".

UPCOMING CONFERENCES

MESOZOIC GEOLOGY CONFERENCE, BRISBANE
23-26 September, 1996

The Conference is being hosted by the Queensland Division of the Geological Society of Australia (GSA), and the IAH-Australia. **IAH** has accepted an invitation to be sponsor and organiser of one session. The preliminary program outline has three streams (A: Geotectonics; B: Mineral Resources; and C: Groundwater, Coal and Petroleum).

On Thursday 26 Septemeber will be the following hydrogeology sessions: (i) Groundwater resources and utilisation, and (ii) Groundwater chemistry and fluid movement in Mesozoic basins. There will also be a poster session of hydrogeology. A feature of this conference is that the proceedings will consist of extended abstracts/short papers, and so be a very useful volume.

WATER MANAGEMENT CONFERENCE
November 17-19, 1996
Abu Dhabi, United Arab Emirates

Aims at technology and solutions to water resources challenges, with emphasis on arid and semi-arid regions. The 3 day program will include contributions from 24 water resource professionals. Management and optimal use is an important theme, and the effective utilisation of modelling.

Sponsored by:
National Drilling Company (NDC - USGS) Groundwater Research
United Nations Development Programme

Registraion is US$ 1,395, which includes documents, proceedings, breakfasts, lunches and refreshments.

Information from:
ACCESS Conference and Seminar Organisers
PO Box 27330
Abu Dhabi, United Arab Emirates
tel: 971 2 315-637 fax: 971 2 315-630

WATER IN THE BALANCE
16-21 March, 1997
Melbourne, Australia

This will be the 17th Australian Waste Water Association (AWWA) Federal Convention. The overall theme is designed to address issues such as maintainence of water quality, sustained enhancement of the environment, risks to human health and welfar, economic dcompetition for water resources, business practices, administration and ownership. The convention will appeal to all those involved in water management.

The major sponsor is Water Services Association of Australia

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CONFERENCE NOTES

GROUNDWATER DISCHARGE: AN IMPORTANT FACTOR IN THE COASTAL ZONE

The International Symposium on Groundwater Discharge in the Coastal Zone was held in Moscow, Russia, July 6-10, 1996, under the joint sponsorship of the Russian Academy of Sciences and the Land-Ocean Interactions in the Coastal Zone (LOICZ) Core Project of the IGBP. The meeting brought together more than 50 participants from 16 countries, representing a wide range of research interests in marine and terrestrial geosciences, hydrology, and engineering. The major motivation for the Symposium was the LOICZ requirement to determine C, N, and P dynamics in the coastal oceans for input into biogeochemical models. In addition to presenting overview papers and results of investigations, participants carried out a thorough review of the state of scientific research on fluxes of water and materials between land and the coastal marine environment, the probable significance of such fluxes, and needs for further investigation.

This was the first international meeting focused specifically on issues related to submarine groundwater discharge, and as such it was particularly successful in developing recognition by participants of the large number of researchers and wide range of methods and problems involved in the study of interactions between groundwater and coastal marine environments. Communication and recognition of the field of study as an important interdisciplinary field were greatly enhanced.

Many participants were initially uncertain about the overall significance of groundwater discharge to coastal zone processes, or about how their specific results might relate to other areas or research approaches. This uncertainty was rapidly dispelled by the growing appreciation that discharge of groundwater from coastlines and shallow marine sediments is an important environmental and biogeochemical factor in many parts of the world, delivering some dissolved constituents to the ocean at rates comparable to those provided by regional river inflow. This delivery, and its attendant effects on coastal productivity and biogeochemistry, is believed to be undergoing significant changes as a result of human intervention in local hydrologic cycles and global climate.

During the symposium, terrestrial researchers became acquainted with the power and unique information provided by oceanographic tracer studies and modelling, while the oceanographers gained an appreciation of the diversity of hydrogeologic and geophysical techniques being applied to the problem from the landward side. All participants recognised the opportunities and challenges of working in a field that is both a disciplinary, as well as an environmental, interface.

A specific topic that emerged in discussions was the importance of biogeochemical reactions between terrestrial groundwater, seawater, and solid material within the mixing zones of coastal aquifers and sediments. These processes can be important sources of some dissolved solids that cannot be predicted on the basis of freshwater fluxes alone. Recognition of such interactions forces hydrogeologists and marine scientists to examine and reconcile the assumptions and definitions of their separate fields in order to co-operate on problems of common interest.

Symposium participants adopted the following specific conclusions:

* Groundwater flux to the coastal marine environment is an important biogeochemical and environmental factor in many coastal regions;
* The physical and chemical processes involved in groundwater flux to the coastal marine environment are complex, and highly variable in space and time; and, .
* In view of the general scientific significance of the subject and to ensure that groundwater fluxes are properly accounted for in the LOICZ Project, it is necessary to expand our understanding of coastal groundwater flux, and to improve the methods available for its assessment.

Future goals identified were:
- elaboration and improvement of methods, approaches, and field/analytical equipment;
- study and assessment of the significance and mechanisms of submarine groundwater flux;
- investigation of contributions of groundwater to biogeochemical regimes in the coastal zone;
- assessment of potential changes in groundwater flow to the coastal zone due to global change and human activities.

Symposium participants recommended a number of specific actions. To promote information exchange, distribution, and general co-ordination, participants agreed that it was necessary:
* To prepare, distribute and maintain:
- a directory of researchers and agencies;
- a bibliography of relevant publications; and,
- a catalogue of data sources and access information.
* To publish and distribute:
- Symposium meeting report;
- Symposium proceedings document; and,
- an overview report summarising and reviewing relevant concepts and methods of groundwater flux assessment.
* To establish an international working group to co-ordinate and promote the further development of the field.

The Symposium participants recommended the establishment and co-operative use of test sites and case study areas that will provide integrated investigations and opportunities for methods development and comparison. The characteristics of such sites and studies should include some or all of the following:
-application to areas of potentially significant groundwater flux and/or changes in flux;
- application of multiple methods and intercomparison of results; and,
-links to LOICZ research activities such as biogeochemical modelling.

Although other sites will be identified in the future, participants constructed a preliminary list of possible test or case study sites that included the Baltic Sea, Mediterranean karst locations, the North China coast, the Black Sea and the LOICZ Core Research sites (Indonesia, Malaysia, Philippines, Vietnam, and study sites identified by the biogeochemical modelling node).

For further information contact one of the organisers:

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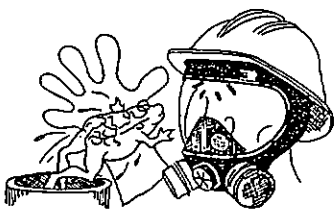
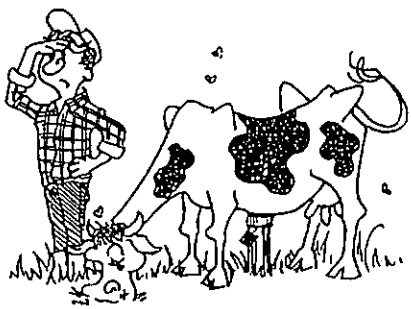
SOFTWARE

CHEMPOINT - GROUND-WATER

Scientific Software Group announces a new program, ChemPoint - Ground-Water Data Tracking System for Windows. ChemPoint is designed to supplement US EPA's GRITS/STAT (Ground-Water Information Tracking System with Statistical Analysis Capability). Designed to supplement GRITS/STAT, check out these helpful features in ChemPoint. Assistant pages take you step-by-step through each procedure. The complex US EPA coding system is simplifed with drop-down selection lists. Bubble hints detail the function of each entry and button. Full parameter names are always displayed. Help text describes the user of each data entry form. Extensive context-sensitive on-line helpis available at all times. Interactive tutorials help teach you the program. Convert data files to and from GRITS/STAT 4.2 format. Improved data reporting. Easily store data for each facility in a different directory to improve access speed and add security. Export data files for importing to contouring packages.

If interested, e-mail us your address for our new "1996 Updated Products Guide" which contains other hydrology, geology and environmental software plus specific information on ChemPoint.
Attn. Susan Hardy
Scientific Software Group
P.O. Box 23041
Washington, DC 20026-3041
e-mail: info@scisoftware.com
Ph:(703) 620-9214 Fax:(703) 620-6793





From a useful field manual called "How to Sample Ground Water and Soils" by Peter Garrett

Article submitted by Don Scott of Rust PPK in Sydney, and by the courtesy of the Department of Land and Water Conservation, NSW.

W. H. WILLIAMSON, M.Sc.
Senior Hydrogeologist, Water Resources Commission
New South Wales

Water Divining Fact or Fiction?

"Is there anything in water divining?"
Ask this question in any group of farmers and graziers and you'll certainly start an argument, for there are few more controversial subjects in rural circles.
But amongst prominent scientific authorities, such as the United States Geological Survey and the Soviet Academy of Sciences, we find that the subject is not controversial at all.

SCIENTISTS the world over are agreed, as a result of numerous investigations over the years, that the practice of divining has no relationship to underground water. Furthermore they are agreed that the many and varied concepts diviners have of groundwater occurrence and movement, particularly with regard to so-called "underground streams", are usually quite misleading.

This must seem strange to diviners or believers in divining, but they should remember that many countries spend a lot of money on investigations of ground water resources and would therefore be only too happy to use a forked stick or a piece of fencing wire if these could provide the information needed.

Back in 1938 Bert Wilson wrote an article which he called "Debunking Divining", and in introducing it he humorously suggested that "There's more water underground than you can poke a stick at". Since then thousands of copies of this article have been sent to readers asking for our opinion on the subject, but in view of recent widely publicised claims of believers in divining "Power Farming" decided it was time to publish another article on the subject written this time by a practising hydrogeologist and having official backing.

History shows that it is human nature to surround with an aura of mystery any subject which cannot be explained. However, with sufficient knowledge the mystery is dispelled. Thus, for an observer not aware of the factors controlling the occurrence of groundwater, the diviner's claim to predict the unknown has a natural appeal. But if he (or the diviner for that matter!) took the trouble to find out what is known of groundwater and divining, he would not be misled by such claims.

Perhaps the factor that has most influenced many people to believe in divining is that they have seen or heard of a bore or well constructed on a divined site and yield a water supply, but this result by no means proves the validity of divining. When it is realised that in many areas groundwater conditions are so favourable that water can be obtained by boring virtually anywhere, it will be appreciated that the success of a bore on a divined site is not necessarily a credit to the diviner.

Going to the other extreme, in areas where groundwater conditions are unfavourable there is rarely any belief in divining because too much money has been wasted on failure bores.

THE practice of divination extends back into the mists of antiquity and an extraordinary variety of claims have been made for it. As well as for locating so-called "underground streams", it has been applied to locating ore deposits and buried treasure (there is no record of such diviners becoming rich!), detecting criminals, finding missing animals and persons, diagnosing diseases, determining sex of unborn babies and unhatched chickens, and other equally diverse purposes. What is amazing, however, is that even in this enlightened day and age some people still throw logic to the winds and believe such claims, even though they have so often been refuted.

W. H. Williamson, M.Sc.

In past years there have been numerous scientific investigations on water divining, and perhaps their results can be summarised by quoting the late Dr. O. E. Meinzer, one of the world's leading authorities on groundwater hydrology: "It is doubtful whether so much investigation and discussion have been bestowed on any other subject with such absolute lack of positive results. It is difficult to see how for practical purposes the entire matter could be more thoroughly discredited . . ."

A considerable variety of implements are used by diviners. The most common are forked sticks, and L-shaped pieces of wire, but wire hoops, pendulums and even hand-saws have their advocates.

However, whatever is used, the essential feature in the operation of any divining implement is that it be held in a state of unstable equilibrium. Consequently, an appropriate slight movement of the hands, or change in muscular tension, will result in an accentuated movement of the implement. For example, the forked stick is held in a state of tension but it requires little movement to convert this into a state of torsion. The consequent twisting effect results in an impressive-looking sudden downward movement of the butt end of the stick.

In the case of the L-shaped piece of wire, the principle involved is simply that of a horizontal pendulum. The wire is held with the short end of the "L" as the vertical axis and if this is tilted slightly the long end of wire will swing in the direction of tilt. The "stream" is then taken to be in this direction.

Some diviners use a bottle or tube to hold the vertical wire, ostensibly ruling out any suggestion of moving the wire by hand, but, of course, by removing the friction between the wire and the hand, the implement becomes even more sensitive to slight tilting.

Similarly the operation of other divining implements depends on an initial state of unstable equilibrium; none of them do anything that does not conform with the laws of physics.

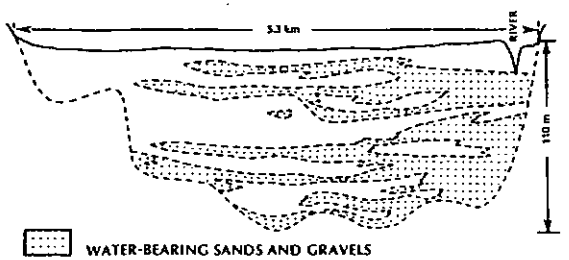
Hydrogeological assessment, not divining, led to the construction of this bore. It is tapping water-bearing gravels at a depth of about 124 metres in the Murrumbidgee Valley and is shown here being pump tested at 150 litres per second.

AUTHORITIES who have studied the matter mostly attribute the movements of divining implements to the effects of subconscious muscular action. (Where the action is conscious the diviner is obviously fraudulent, but such cases are not being considered here.) In any event, whatever the cause of the movements, it has been clearly established that it is not the presence of water or, for that matter, any other mineral.

There seems little doubt that the human element is involved, whether the diviner be conscious of it or not. For example, it has been found that the most successful diviners are those who are good observers and well experienced in the area in which they operate, their failures becoming less frequent as their experience increases. In fact, if the groundwater conditions are particularly favourable, they may not have had any failures at all. But if such diviners are taken to an area where different groundwater conditions prevail it is usually found that the diviner indicates the apparent presence of water just as if the conditions were those of the area to which he is accustomed. These circumstances, naturally, often cause financial loss to the landholder.

If divining is discredited, how is the presence of underground water to be determined? The science of hydrology provides the answer, and the requirements are a thorough knowledge of geology and the factors governing groundwater occurrence and movement.

Even leading exponents of divining admit the necessity of observing geological features if one wishes to be successful in locating water. Thus, Le Vicomte Henry de France in his book "The Modern Dowser: A Practical Guide to Divining", states: "It is useless to look for water where



This sketch, showing the distribution of water-bearing sands and gravels in the alluvial in-fill of the Lachlan River Valley, near Gooloogong, NSW, as determined by test boring, indicates how a diviner can easily gain a reputation for success in such areas.

geology tells us there cannot be any. The dowser then must have a special knowledge of geology and especially that of the country where he is working".

Theoretically, of course, if a diviner has the "gift", such knowledge should not be necessary for success.

ONLY an elementary knowledge of geology is required to realise that the diviner's conception of "streams" is largely erroneous, the only common rock type in which water is found in true streams being limestone. Here the water actually dissolves the rock to form channels and examples of these can be seen in limestone caves.

In other rocks water occurs in a variety of conditions, e.g., in joints or cracks, in bedding planes or partings between rock layers, in beds of porous rock such as some sandstones, or in beds of sand or gravel in alluvial deposits.

Factors, such as rock types and structures, topography and drainage and amount and seasonal distribution of rainfall, are all important in controlling not only the presence of water but also its quality and yield. Thus groundwater conditions may often be complex, and it requires a hydrogeologist (i.e., a specialist trained both in hydrology and geology) to assess these factors.

It is not claimed that a hydrogeologist is infallible; he can be guided only by the available evidence and often this is far from complete. Nevertheless, application of scientific methods in locating groundwater is far more successful than divining.

IN conclusion the accompanying table from the New South Wales Water Conservation and Irrigation Commission's Annual Report for 1945 is presented. It is particularly significant because statistics on the comparative results of boring on "sites divined" and "sites not divined" are rare.

The table summarises the results of the 3,638 bores constructed by Commission boring plants between 1918 and 1945, the last year in which such records were maintained. In approximately half of these cases the landholder required the bore to be constructed on a divined site.

BORES CONSTRUCTED BY THE (THEN) WATER CONSERVATION & IRRIGATION COMMISSION BETWEEN 1918 AND 1945

	Divined		Not Divined	
	Number Sunk	%	Number Sunk	%
Bores in which supplies of serviceable water estimated at 450 litres per hour or over were obtained	1,291	70.4	1,516	83.9
Bores in which supplies of serviceable water estimated at less than 450 litres per hour were obtained	185	10.1	96	5.3
Bores in which supplies of unserviceable water were obtained	87	4.8	61	3.4
Bores—absolute failures, no water of any kind obtained	269	14.7	133	7.4
TOTAL	1,832	100.0	1,806	100.0

In New South Wales, the Water Resources Commission has a staff of hydrogeologists and technical advice on groundwater problems or prospects can be obtained on application. Financial assistance is also available to landholders for approved water supply schemes.

It will be noted that the figures show that the results of drilling on sites not divined have been much more favourable than those having the "advantage" of being divined. In fact, the percentage of failure bores on divined sites is about twice that for sites not divined.

It is pointed out also that prior to the introduction of new regulations in 1947 the Commission was committed to boring on whatever site the landholder stipulated, and many of the undivined sites were unfavourably located. Since then, however, the Commission has constructed bores only where hydrogeological assessment indicated that there were reasonable prospects of obtaining water, so that today, failures are rare.

And this without the aid of a diviner to trace the elusive "stream"!

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Petrolia: 1874-1974.
Published by Petrolia Print and Litho Ltd, Petrolia, Ontario, Canada
1974.

CHAPTER SIX

The Romance of Foreign Drillers

The full story of the foreign drillers, Petrolia's practical graduates who travelled the civilized world in the pay of oil companies, has never been written. Indeed so widely scattered are the people, the places and the records that it can never be reassembled. It is the fervent hope of Petrolia historians that it will at least be attempted.

Victor Lauriston, author of Lambton County's Hundred Years, published in 1949 for the County's Centennial, wrote of these amazing men as far back as 1924. An extract follows:

Those who know declare that the foreign driller can't quit. In witness whereof it cited the experience of Duncan McIntyre, one of the finest of the Canadian experts.

In the early years of the war (World War 1) McIntyre was working the Burma fields at Yenang UYaung. He was crushed under a two-ton pump. His left knee, both collar bones, left jaw bone, right shoulder blade, right arm (in two places); practically every rib — in all, twenty-one bones — were broken.

An ordinary man would have died on the spot. But it takes more than an ordinary man to make a Canadian driller. McIntyre spent weeks in hospital, hanging betwixt life and death by the slenderest of threads. At times his pulse almost reached the vanishing point. His temperature fell lower than doctors had ever thought possible for a living man.

Yet, after a long siege, the very tedium of which would have killed most men, McIntyre on crutches tottered aboard ship at Rangoon. The vessel escaped submarine perils. McIntyre, after travelling 12,000 miles, was sufficiently recuperated to walk ashore at New York with the aid of a cane.

At London a son met him with tidings that the wife and mother, at Sarnia, was dead.

Later, McIntyre quit drilling "for good." He launched a promising manufacturing enterprise at Sarnia. And . . . at last accounts, Duncan McIntyre is in Burma, drilling. The lure of the bit and sinker is too strong.

No one knows better than the driller himself the inevitability of his return, so long as life is in him. The summer of 1922, at Miri, Sarawak, Alf. Brownlee, at a farewell tiffin given him by the drilling colony, declared emphatically that thenceforth he would "stick close to home." A fellow-driller, writing home at the time, commented ironically:

"Alf. deludes himself with the thought that he is going home no more to roam; but we thinkhe will hear the call of the East very loudly in about six months and will not be surprised if he persuades his wife that she hears it also. The some bright morning the Kahang will drop anchor in Miri Roads. Alf. will drop into the Helen alongside with his case of B.V.D., bottle of chutney and katty of quinine, the happiest man in Borneo, bumping over the bak on the last lap of his journey back to the little old bungalow on the hill."

Alf. Brownlee fooled the prophets, however. He stuck to Petrolia for nine or ten months. Then he left for South America on a three-year drilling contract. That is what a Petrolia driller considers "sticking close to home."

When the Great War broke out, many drillers volunteered for active service. To such, the military or naval authorities, as the case might be, had just one answer, In effect they said:

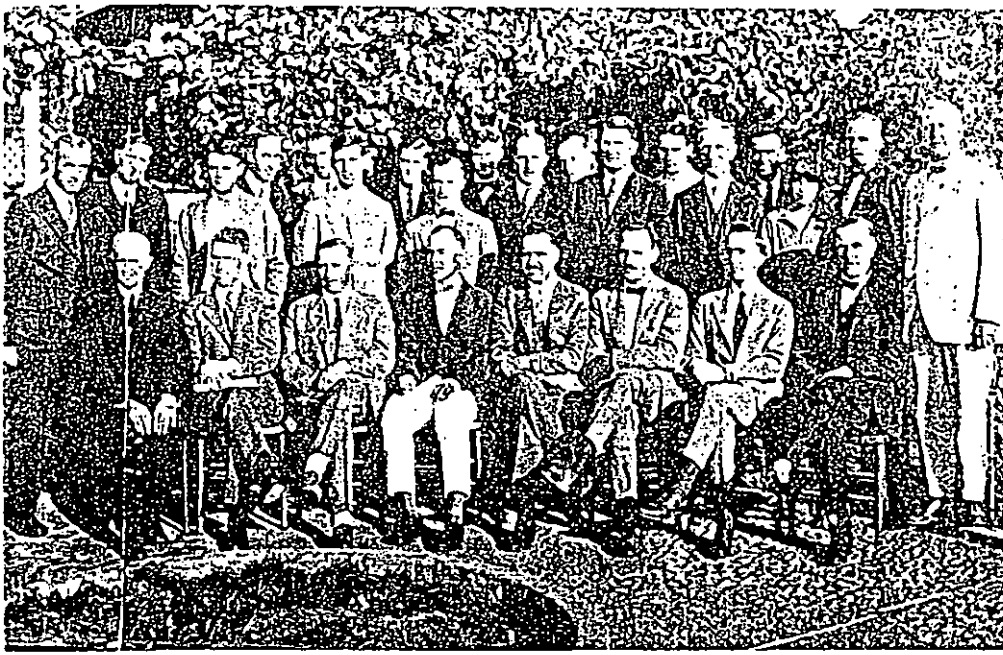
"Quit your kidding and get back to your job. You're a lot more use to king and country right where you are. Any driller who goes soldiering ought to be shot at sunrise."

Absolutely correct. Fuel oil for battleships and submarines, petrol for airplanes and tanks came to be, ultimately, deciding factors in the war. The war feverishly stimulated production in the existing fields, and the development of new fields. It practically brought the present Persian field into existence. There, Canadians, laboring under a tropic sun, drilled well after well, and laid pipe lines to link the field at Ahwaz with the refining port of Mohammerah. Now and then they shouldered rifles and set bayonets, repelling Turkish raids. General Townshend's expedition, though in a military sense it ended disastrously at Kut-el-Amara, nevertheless removed for the balance of the war the menace to the Persian fields.

DRILLING IN MANY CLIMES

Petrolia Drillers Are to be Found Throughout the World Wherever There is Oil—Ebb and Flow Like the Tide—They are Steady Workers for the Most Part and Save Money.

As mentioned in Victor Lauriston's recent article reprinted in The Advertiser-Topic a couple of weeks ago, Petrolia, as far as the multiplicity of its world travellers is concerned,



These are Petrolia and district men who were working the oil fields in Talara and Negrilos Peru in 1926. The picture comes to us from Flora Stauft who taught their children. TOP ROW. L to R: Wynne Merrill, Wm. Henderson, Wm. Braybrook, George Brake, Cliff Hackett, T. Ward, Atwill Drope, Ray Braybrook, Don MacGregor, King Houston, Earl Houston, George Rawlings, Ralph Bennett, Joseph Burns, Jim Dean. Flora (McDonald) Stauft, teacher in Talara, 1923-26; Wm. White, Bruce Dunlop. SEATED, L to R: Scotty Miller, Robert MacGregor, Frank B. Braybrook, George Brown, Joe Wilkie, Jerry Currie, Dalton Hinman, Tom McCort.

stands alone. The following list of drillers who have operated in various countries throughout the world was compiled by Mr. W. W. McRae, himself a driller who has travelled extensively. By it, it will be seen that Petrolia drillers are in demand wherever there is oil. They are considered the best in the world, steady and reliable, but no matter where located they never forget the old town and most of them count on six months' furlough every three years, to revisit among relatives and friends. The list is as follows:

Australia

Jas. Longhead, W. Woodley, F. Tichbourne, Jas. Tichbourne, R.Tichbourne, Jno. Tichbourne, Wm. Johnson, Robt. Johnson, Arthur Johnson, Wallace Johnson, Lath Keith, Geo Fair,Thos. Fair, Richard Fair, Geo.Forsyth, Alex Brown, John Brown, Jas. Brown, Jas. Chalmers, Chas Williamson, Pat Laner, Henery McLister, O. Vanderwater, W. Booth,Wm. Beadle, T. Ivenson, W. Rose.A. McKilop, A. Schooley, W. Stevenson, John Woodley, David Martin, John Martin, Jos. Martin, Chalmers Waddel, John Waddel, J. Waddel, Jos. Thompson, Jas. Hoskins, John Wills, Archie Ralston, S. Ralston, Chas. Belden, Ben Hayden, Irvin Joyce, Chas. Simmons, Arthur Simmons, W. Lindsay, Frank McCann, George McCann, Mat PorterJos. Porter, Jas. Johnson, H. Drader, E. Drader, W. Pauling, W. Booth, Geo. McMillan, Fred England, W. G. MacKenzie, Wm. MacKenzie, J. W. Willoughby, Wm. Courtney, J. McLellan, Thos. Sanson, F. Holbrook, George Morrison, Angus Morrison, George Williams, Jas. McMillan, John Harold, Wm. Harold, Duncan Sinclair, Geo. Loughead, T. Sparham, Jos. Newton, John Bennet, Chas. Bennet, A. Simpson, G.B. Bryson, Elmer Kirby, Pat Shannon, Sam McNeil,Richard Wade, J. Bell, Jas. Morrison, Hecter Morrison, R. McCaig, C. McCaig, W. Huston, Alvah Townsend, Rach Beamer, A. Tomlinson, Sandy Wallen, G. Slack, John Gleason, Wm. Crawford, Wm. Blackwell, Garfield Crawford, F. Crawford, C. Anderson,A. Foyne, Jas. Boyd, D. Cameron, Hugh Cameron, John Simmons, F. W. Johnson, Geo. Johnson, Sam Johnson, Russel Brown, J. T. Brown,Val Vance, Jas. Vance.

RETURNED FOREIGN DRILLERS
AND PETROLIA FRIENDS

BACK ROW, standing: E. Preston, Hugh Young, W. McKeown, Jas. McLister, A. Sutherland, F. Yerks, D. Holmes, T. McCort, R. Newton, C. McGowan. FRONT ROW: Mr. Taylor, E.D. Fletcher, G. Bryson, J.Sanson, John McLister.

Burma, Assam and Punjab British India

t. A. Townsend, Robert Dunlop, David Boyle, ank Nichol, John Doig, Miles Coleman, Jas. ompson, Ed. Thompson, Jas. McLister, Geo. llet,Geo. Bryson, Jos. McGill, S. Brown, A. wn. H. Brown, David Holmes, A. Holmes, m Tracey, Harry Park, Jos. Thompson, Ted Gowan, H. Marchant, W. Beach, A. Dougall, R. McRie, S. Keith, A. Lambert, R. nsickle, Clare Perkins, R. Rainsberry, lliam McCarron, Ed Slack, Reube Slack, T. ck, David Slack, J. Eaglesham, J. Mallott, ll Mullin, Thos. Josh, Eli Josh, William Millan, Thos. McCort, John Flett, Sam nald, Thos. Pore, A. Gilson, G. Miller, W. lis, John Growder, Thos. Collins, W. Gibson, Harold, Jos. Burton, W. Bell, W. Welsh, llace Thompson.

Persia and Mesapotamia

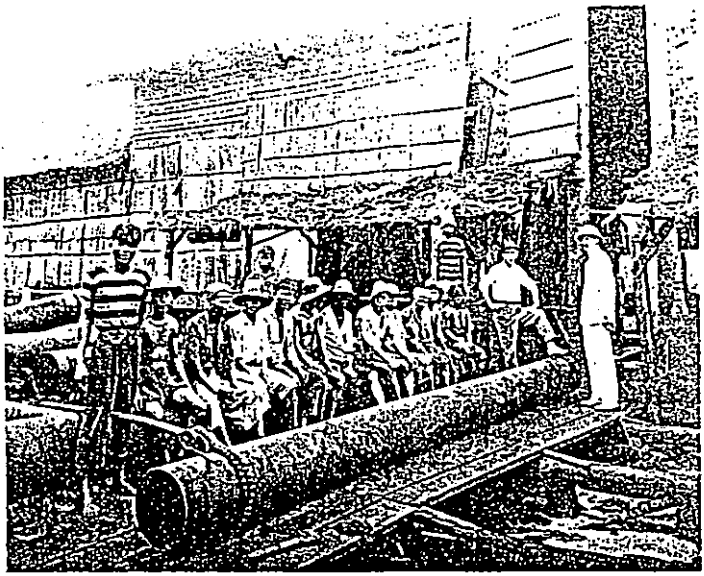
ieo. Tanner, Duncan McNaughton, Jno.Buchn, A. Currie, Jas. Sanson, A. Wosley, T. ck, W. Harris, F. Crawford,T. Knapp,G. rby, D. MacIntyre, J. Wilson, J. Collins, T. lins, Bert Blackwell, T. Paul, J. McCort, Pat en, F. McCann, H. McPherson, H. Tracey, G. ogar, J. Dodge, W. Coie, T. Fred Edward, V. nson, J. Blackwell, F. Blackwell, A. Gibson, Robinson, Geo. Eady, S. Haley, C. Williams, A. McDougald, E. Stokes, J. Miller, Heferdon, T. Pore, W. Booth, R. Yeager, J. Dermind, J. Lambert, W. Lambert, A. Lambert, W. Andison, H. Battice, Thos. Wolsey, J. A. Williamson, W. Wills, E. Booth, A. McKillop, Spun Phillips, E. Kells, J. Fisher, E. Huston, E. Powers, Frank Smith, H. Smith, T. Ivenson, M. Holmes, Ted Holmes, F. Berger, H. Brown, G. Brown, W. Brown, J. Donald, M. Evoy, H. Snider, J. McKelpatric, H. Dickerson, H. Winger, Mac Simpson, Mike McLoud, Harry Lucas, Wm. Brandan, J. Goit, Bert Cox, Chas. Keith, J. Kidd, J.-Hall,B. Josh,E. Josh, C. Ferns, Jas. Douglas, E. Hillis, J. Miller, W. Kerr, A. Johnson, L. Metcalf, W. Drope, T. McGowan, Tom Deacon, D. Holmes, Geo. McCall, J. House, J. Burton, M. Moore, R. Patterson, Al Gudgeon, Len Beadle, W. Parker, Jas. Stevens, Alex Landhue,Sam Phillips, Sam Babcock, John Judson, Peck Perkins, R. Perkins, R. McCrie,C. Booth.

Sarawak British Borneo

Chas. McAlpine, F. Webb, Bloss Sutherland, Stewart Nesbit, L. McMillian, R. Healy, J. Brown, E. McCort, A. Calvert, D. McIntyre, T. Collins, J. Keene, R. Rainsberry, J. Nesbit,F. Drader, Jas. Blake, A. Webb, A. Brownlee, Jay Zimmer, W. Gillespie, Jas. Brookes, J. Patterson, Jas. Rawson, A. Coyne, G. Brown, F. Webb, J. Brown.

Italy

I. Ribbing, Nate Wade, Neal Sinclair, J. Andison, Ken Andison, J. Doig.



Two Petrolia drillers and native labourers on site in Borneo, circa 1920.

Egypt

John Josh, B. Josh, J. Josh Jr., John Growder, G. Ferguson, Jas. Sonson, Geo. Peat, Jas. Wilson, Frank Wade, Mat Collins, J. Collins, John Brooks, Thos. Paul, A. Randal, Fred Edward, A. Calvert, H. Cable, A. Brownlee,G. Haley, T. McCort, J. Keene, F. Lawson,W. Lambert, J. Blackwell, J. Brown, Geo. Eady,Sam Babcock, Sid Judson, Manney Keith, Alex Watson, Jas. Blake, Jim Blake, W.M. Blake, W. Gibson, W. Rawson, F. Wade, R. Vansickle, F. Beresford, S. Kersey, W. Bowles, John Brooks, Tom Knapp, J. McCort.

Island Sumatra

A. Calvert, A. Gibson, Duncan McIntyre,R. E. McCort, J. Sauvey,D. Porter, Sid Judson, T. Collns, John Keene, E. Ivinson, G. Greogary, Geo Craig, J. W. Crosbie, John Crosbie,C. Wallen, E. Wallen, F. Wallen, W. Husband, Leo Wilson, R. Rawlings, John Hall, G. Luxton, E. Winnet, Jase Tichbourne, W. Crawford, G. Crawford, W. Smith, Reube Slack, Chas. McAlpine, F. Babcock, F. W. Webb, W. Gillespie, J. R. Rainsberry,C. Perkins, S. McArthur, Jas. McMillan, Lorne McMillan, W. Laurie, P. Laner, D. Milligan, J. Bennet, Tin Slack, J. Holmes, Geo. Bruce.

Borneo

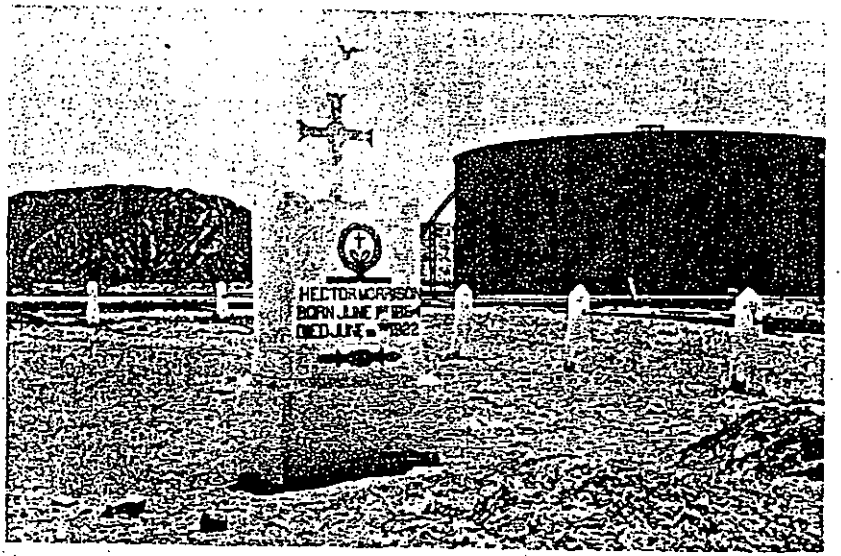
Robert Laird, W. W. McRae, Wm. McKowen, J. Brooks, T. Paul, Jim Brown, H. Brown, J. Lambert, G. Haley, J. Sauvey, Sid Judson, J. Collins, J. Keene, Thos. Ivenson, C. McAlpine, W. Blake, J. Blake, Jas. Blake, Geo. Brake, W. Brake, J. C. Buchanan, S. Phillips, J. Esson, D. Aikens, B. Osborne, F. Babcock, H. Cable, J. Tuttle, John Blackwell, Geo. Bell, Archie Growder, Billie Hill, T. Coleman, Geo. Body, M. J. Woodward, M. J. Woodward, M. J. Kelly, A.Townsend, Alex Robertson, J. Zimmer, F. Zimmer, F. Webb, A. Webb, Geo. Bryson, W. Gillispie, G. Haley, Sid Judson, J. Lambert, J. Collins, J. G. Boyd, J. Blackwell, W. Gibson, F. McCann, J. Cunningham, Gus Slack, W. Rossin, Jas. Rossin, Sam Brown, A. Wolsey, B. I. Isbister, Mike Burns, E. Booth, T. Ivenson, F. Henderson, Jas. McMillan, Scotty Miller, W. Laurie, Jas. McCrie, J. Bennet, Charlie Keck,F. Simmons, Mannie Keith, Frank Wade.

Island Taracken

W. W. McRae, Buzz Isbister, W. J. McKowen, Jas. Boyd, Geo. Peat, Geo. Craig, Jno. Sauvey.

New Caledonia

Wm. Houston, Thos. Fair, Pat Shannon. S. McNeil, Rach Beamer, C. Locke.



The lonely grave of a foreign driller in Peru.

Sagelin Island (Siberia)
Richard Bolton, T. Wolsey, H. Anderson, A. Winters, J. McGill.

Arabia
Thos. Knapp, John Growder, John McCort, Seth Keith, Alex Watson.

Madagascar
David Porter, Albert Huggard, M. L. Yeager.

South Africa
R. Dunlop, John Coryell, W. Coryell, Thos. Anderson.

West Africa
Jacob Perkins, Henry Drader, Gilbert Crosbie, W. Booth, Josh Houston, W. Gibson, Mike Burns, E. Kelly, W. Beach, N. Tomilson, F. Drader, J. Keene, W. Anderson, D. Vansickle.

Algiers
John Webb, Frank Egan.

Crete
W. Blake, Jas. Blake, W. Zimmerman.

Jerusalem
Josh Porter, J. E. Perkins.

Spain
M. L. Yeager, J. Blake, William Zimmerman.

England
Jas. McLister, John Growder, Jas. Blake.

Ireland
William Christner, John Growder, Jas. Booth.

Galicia
Neal Sinclair, R. E. Slack, Wm. McMillan, Josh Hughson, Cyrus Perkins, Andy Fair, W. McCutcheon, D. Slack, Fraser Figdett, Sam Ralston, W. Booth, Quin Zimmer, J. Martin, W. Pauling, Jas. Brown, Howard Smith, W. H. McGarvey, Malcolm Scoot, Buz Scott, Elgie, Scott, Jas. Booth, T. Slack, H. Cable, L. Keith, J. Mervin, H. Voght, J. Lambert, F. Drader, J. Bradley, R. W. Laird, Geo. Craig, Blondey McLean, Thos. McLean, Geo. Normandy, F. Jefferies, R. Tierenen, Thos. McGill, Jas. McGill. Chas. Nicholas, Ernie Nicholas, Chas. Snyders, A. Burns, W. Shaw, Wellington Harding, Robert Hill, Geo. Burns, Jacob Perkins, J. Eli Perkins, Sandy Wallen, C. Johnson, D. Johnson, Jas. Woolsey, Geo. Tanner, Jas. Fowler, Admiral Keith, Charlie Keith, Seth Keith, W. Keith, S. Daniels, Jean Vansickle, Rhes Vansickle, John Connely, John MacIntosh, Geo. MacIntosh, H. MacIntosh, W. Thompson, C. Perkins, Fred McGarvey, J. E. Boyd, John Markle, Geo. Childs, S. Babcock, Pat Shanon, Jas. Browning, Gilbert Crosbie, E. Wallen, C. Wallen, William Slack, Reuben Slack, W. Bowles, W. Zimmerman, Jas. Rowe.

Roumania

A. Ralston, John Drope, W. Courtney, A. Fair, Neal Sinclair, William Woodley, G. Fair, W. McMillan, Kenneth Andison, Manney Keith, W. Keith, R. Vansickle, Chas. Vansickle, Jas. G. Boyd, C. Sniders, G. Craig.

Russia

Jas. McGarvey, Albert McGarvey, G. Crosbie, E. Wallen, C. Wallen, W. Bowles, Honk Lambert, Richard W. Boulton, Thos. Wolsey,

Germany

J. E. Perkins, Jas. Fowler, Neal Sinclair, Geo. Tanner, G. Sniders, G. Craig.

Poland

Jas. Booth, Ernie Booth, C. Sniders, W. Harding.

Bavaria

James Booth, Ernie Booth.

Alsace-Loraine

Gilbert Crosbie, E. Wallen, Chas. Wallen, Angus Sutherland, Wm. Mairs, Sam Phillips.

New Zealand

Ashton Simpson, Henery McLister, Orm Vandewater, E. Drader, William Booth, Geo. Fair, Richard Fair.

British New Guinea

Geo. Bryson, E. Kerby

Celebes Island

Thos. Knapp, John Brooks.

Ceram Island

Fred Webb, Geo. Bryson, Arthur Lambert, Robert Parker, Pat Wilcox, W. J. McKowen.

Java Island

Josh Porter, Malcolm Scott, W. Covert, J. C. Buchanan, Duncan McNaughton, Yank Johnson, T. Paul, Flo Snively, Si Zimmerman, Thos. Vansickle, Fred Simmons, Pat Lennan, Chas. Wallen, Spot McArthur, A. Haley, Thos. Ivenson, Wm. Thompson, W. J. McKowen, Sid Judson, A. Gibson, A. Lambert.

Sumatra Island

Robert Parker, R. W. Laird, T.C. Waddell, R. Vansickle, Josh Hughson, W. W. McRae, John Stafford, W. J. McKowen, G. Eady, J. Garrison, Jean Vansickle, S. Babcock, A. Colbourne, E. Balls, Jos. Volway, A. Rouse, Jas. Vansickle, M. L. Yeager, Fred Lawson, R. Yeager, J. Brooks, T. Knapp, John Tracey, T. Paul. B. Sutherland, Jas Brown, H. Brown, E. Volway.

Venezuela

John Josh, W. Cole, Doctor Mott, Bloss Josh, Eli Josh, O. Wolsey, Ivan Russel, Fred Zimmer, H. Marchant, Thos. Josh, Jas. McMillian, A. Wolsey, Con. Peat, G. Williams. A. Calvert, W. Culver, Jas. Wade. A. Holmes. Dot Lambert, W. Lambert, T. Ivenson, John Judson, W. Kitchen, Geo. Glover, Archie Currie, Jas. Boyd, Jas. Sanson, W. Manross, John Keene, C. E. Lindquist, W. H. Harris, Ted Harris, W. Rawson, Jas. Stevens, R. E. McCort, W. Kay. A. Brownlee, Herbert Hussey, H. Patterson, Roy Gregory.

Colombia

A. Burns, F. R. Webb, Geo. Bryson, R. Miller, A. Wilson, A. Mewburn, F. Douglas, Bert Strait, Geo. Miller, J. Bagnal, G. Currie, D. Holmes, Dell Mullin, Dliff Collins, M. Collins.

Equador

Jas. McLister, Geo. Rawlings, W. McCutcheon, Sam Brown, Spot McArthur, J. Eaglesham, W. D. Hinman.

Argentine Republic

John Blackwell, R. Blackwell, Thos. McCort, Jas. McLister, Scotty Miller, David Holmes, A. Calvert.

Peru

A. Burns, Geo. Brake, Alf. Burns, Alex McAlister, H. Morrison, H. T. Morrison, G. Bennet, T. Bennet, W. Henderson, Cliff Hacket, G. McDonald, A. Harper, D. McGreogar, J. Wilkin, W. Kitchen, H. Hussey, W. Gillis, Geo. Miller, Geo. Rawlings, F. L. Braybrook, Bruce Dunlop, Geo. McDonald, G. H. Trangmar, J. Wolsey, Jas. Wilson, Wynne Merrill.

Brazil

Alexander McAlister, Hector Morrison, Kenneth Anderson.

West Indies

David Wright, John McCort, Geo. Peat, Thos. McCort, Thos. Paul, G. Adams, H. H. Anderson, W. Bowles, J. Brown, Jas. Peat, R. Craise, F. Wicks, Geo. Craig, A. Lambert, J. Wilkin, W. Wills, Geo. Brown, H. Brown, C. Peat, Noble Ward, W. Kitchen, M. Thompson, D. McNaughton.

The following list was added in the Advertiser-Topic the following month, March 6, 1924.

Tarakan

Frank McCann.

Borneo

John Stokes, Alvah Townsend, M. J. Woodward, James Templeton, H. Cable.

Barbados

Chas. Wallen, J. McCort, George Craig.

Persia

H. Hedden, George Porter, Ray Patterson, T. Warner, C. Warner.

Egypt

T. Wardell, T. Collins, F. Stinson, J. Growdes.

India

W.S.D. Fraser, W. Courtney, A. Townsend.

Newfoundland

T. Collins, J. McAlister, J. Brown, James Wade.

Article submitted by Rob Ellis of Department of Natural Resources, Queensland. Apologies for the reproduction quality, but it has been through several generations of photocopying. This will especially have relevence to those hydrogeologists who have worked with North American drillers and experienced their "frontiersmanship".

Information Bulletin

Water Resources

IRON BACTERIA IN WATER BORES

ISSN No 0814-4001

INTRODUCTION

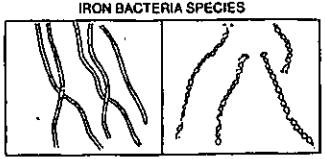
Iron Bacteria are found in all parts of the world, with the exception of the southern polar region. They occur naturally in dams, swamps, watercourses, lakes and groundwater. The reported occurrence of iron bacteria in bores has increased rapidly throughout Queensland in recent years. This bulletin discusses the occurrence, treatment and prevention of iron bacteria-related problems in bores.

WHAT ARE IRON BACTERIA

Iron bacteria are micro-organisms which obtain energy by oxidising soluble ferrous iron into insoluble ferric iron which then precipitates out of solution. This energy is used to promote the growth of thread-like slimes which, together with the ferric iron, form a voluminous mass.

Many species of iron bacteria have been identified. The diagrams below show two of the more common varieties found in groundwater in Queensland. There are also some bacteria which live on manganese in water. However, as most groundwaters contain less concentrations of manganese than iron, it is iron bacteria which have presented the majority of problems in bores.

IRON BACTERIA SPECIES



CRENOTHRIX Magnification x 300

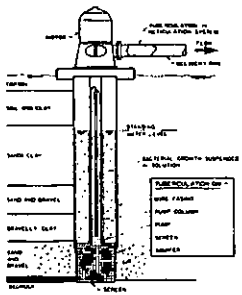
GALLIONELLA Magnification x 900

EFFECTS ON BORES

Whilst most groundwaters contain a certain concentration of ferrous iron, iron bacteria do not affect all bores.

When iron bacteria infect a bore, the resultant growths may either suspend in solution or tuberculate (deposit growth) onto the bore casing, screens or the aquifer itself. Tuberculation may also occur in pumping equipment and reticulation systems. As a result, restrictions, or even complete blockages of free entry of groundwater into the bore and through the reticulation system, may occur. Decreased pumping efficiency and increased pumping costs are the likely outcomes. Reticulation systems may also become clogged.

Layouts for trickle or drip irrigation systems are particularly susceptible due to the fine aperture size at point of delivery. Tuberculation on submersible pumps can cause burnout due to overheating.



WATER BORE INFECTED BY IRON BACTERIA

In fixing to metallic fittings the bacteria are thought to secrete an acidic substance which increases metal corrosion resulting in deterioration of bore casing, screen, pump, column and reticulation system.

Iron bacteria may cause a decrease in the standard of water quality with adverse effects on taste, colour and odour, and lead to undesirable staining, usually of a reddish nature.

HOW DO BORES BECOME INFECTED

There is some debate as to why certain bores suffer adversely due to iron bacteria while other bores never become infected.

The following is a list of some possible methods of a bore being infected:

- The bacteria may be in the groundwater before the bore is drilled. The drilling operation, or introduction of various additives, may stimulate the bacteria. The bore permits contact of the groundwater to the atmosphere.
- Bacteria may be physically transported from bore to bore via drilling rigs or pumping equipment. Water taken from swamps or creeks for use in the drilling operation may be contaminated.
- Bacteria may travel through an aquifer system and thus infect a previously uninfected bore.
- Bacteria may be introduced by floods inundating an unsealed bore.
- Airborne bacteria may contaminate unsealed bores.
- Changes in the basic chemistry of groundwater at any particular location may be instrumental in providing an environment for the bacteria to become established.

IDENTIFICATION

Instances of iron bacteria in bores are usually discovered by noticing one or more of the following symptoms:

- Reduction in the pumping capacity of the bore
- Deterioration of the physical aspects of water quality (colour, odour, taste and staining)
- Supply failure caused by motor burn out in submersible pump
- Sand entry into bore
- Tuberculation on pump column, bore casing, screens and reticulation system

Positive identification of iron bacteria contamination may be achieved by microscopy or biological techniques. However, consideration of the symptoms displayed by a subject bore will usually indicate if iron bacteria infection has occurred.

BORE REHABILITATION

If it is confirmed that iron bacteria contamination has occurred, the following rehabilitation program is typical of what would normally be recommended and involves both mechanical and chemical treatments.

Chemicals used in the treatment process usually consist of an inhibited acid and an antibacterial agent.

Mechanical treatment will be necessary in most cases to remove encrustations to ensure the effectiveness of chemical disinfection of the bore and water bed. This may require the use of specialized equipment, hence you should seek advice from the Commission before proceeding.

(i) Determine pH of the bore water and test drawdown behaviour for comparison after treatment.

(ii) Mechanically clean the interior of the casing and screens. Bail or air lift scrapings to waste.

(iii) Dose bore with appropriate chemicals. The bore should be agitated intermittently with a surging block or jetting tool for a period of at least 24 hours. This ensures that the chemicals will infiltrate the water bed. Where a specific section of a bore is to be treated (e.g. slotted or screened section), a tremie pipe may be used to place the chemicals at the specific area of interest. This results in a lower cost than treatment of the complete bore would entail.

(iv) Pump chemicals to waste along with any residues until pH is within 0.5 units of the value before treatment.

(v) Test drawdown behaviour of the bore. If the treatment has been successful, the drawdown should be less than previously measured.

Once the rehabilitation of the bore is complete, ongoing surveillance of the bore's pumping capacity and water quality should be made. Future disinfection/rehabilitation of the bore should be carried out as required.

Several companies in the groundwater industry now market a range of products designed specifically to rehabilitate and disinfect bores with iron bacteria problems.

IT SHOULD BE NOTED THAT ALL CHEMICALS USED IN THE REHABILITATION PROCESS MAY BE DANGEROUS AND CORROSIVE, AND APPROPRIATE SAFETY PRECAUTIONS MUST BE TAKEN AT ALL TIMES.

BORE DISINFECTION BY CHLORINATION

Bore rehabilitation can be rather involved and expensive, hence preventative measures should be taken to avoid major infestation/encrustation occurring.

It is recommended that any new bore, or any existing bore where possible contamination is suspected, be disinfected.

This may be achieved by dosing it with liquid chlorine to a level where there is between 50 and 100 milligrams/litre of free chlorine in solution in the bore. Higher doses may be required in some cases, but chlorine is highly corrosive to metals and care should be taken to avoid unnecessary contact with metallic fittings.

Chlorination would be carried out in a similar method as outlined in stage (iii) of bore rehabilitation.

Chlorination treatment itself may cause the precipitation of ferric hydroxide, especially where the ferrous iron concentration is high. The chlorinated water, along with any precipitates, should be pumped to waste until pH is within 0.5 units of the value before treatment.

Reticulation systems may also be disinfected by chlorination.

CHLORINE MUST NOT BE USED IN CONJUNCTION WITH OTHER BORE TREATMENT CHEMICALS. MOST CONTAIN ACIDS WHICH WILL REACT WITH LIQUID CHLORINE AND GENERATE CHLORINE GAS AS A BY PRODUCT.

GROUNDWATER MANAGEMENT POSTGRADUATE PROGRAMS
-Short Course Mode

U T S

University of Technology, Sydney

The National Centre for Groundwater Management (NCGM) at the University of Technology, Sydney is recognised by the Federal Government through the Land and Water Resources Research and Development Corporation as a National Centre for Training, Research and Consultancy in Groundwater and Environmental Applications.

A range of postgraduate programs is being offered currently:

- Master of Engineering, Master of Science (1 year course work degrees)
- Graduate Diplomas (Engineering or Science)
- Master of Engineering and Master Science (Research)
- PhD
- Graduate Course (15 weeks)

Flexible Delivery Mode:

- Short-course delivery format
- Full-time
- Part-time

Study areas include:

- Groundwater Contaminant Transport Modelling,
- Quality and Quantity Optimisation Strategies for Water Resource Development,
- Waste Management and Groundwater,
- Contaminated Land Evaluation and Rehabilitation,
- Bore Fouling and Maintenance,
- Practical Areas of Hydrogeology including Geophysics, Hydrochemistry and Microbiology aspects,
- Land and Groundwater Salinity

For Applications and Information contact:

Professor Michael J. Knight
Director
National Centre for Groundwater Management
University of Technology, Sydney
PO Box 123
Broadway NSW 2007, AUSTRALIA

Phone: (02) 9514 1984
Fax: (02) 9514 1985
E-mail: groundwater.management@uts.edu.au

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PHONE: (02) 261 5793
FAX: (02) 261 5934

VISUALISING BOREHOLE DATA USING A DESKTOP GIS

AGSO Record 1996/18
just released

Prepared by Robyn Gallagher,
GISolutions under contract to AGSO.

This report describes a method for visualising complex borehole data using a desktop GIS. The data can be stored in any tabular data base structure, and are displayed and analysed using new software modules added to the ArcView2 desktop GIS package.

The report deals with the borehole data model, which is a series of tables attached to points locating the bores, in the traditional "one-to-many" situation. It also describes how ArcView is able to use that data model, and outlines some analysis tools implemented in their Avenue language

The technique is being used to link waterbore data with the project GIS for the Western Water Study in the Northern Territory. In this case, the original waterbore data are accessible as dBase tables.

The package is relevant in many geological situations, such as drillholes and field sampling programmes, where many pieces of information need to be associated with each location on the ground.

Record 1996/18 costs $14 plus $5 postage
from AGSO Publication Sales,
Box 378, Canberra, ACT, 2601

For further information contact Gerry Jacobson at AGSO
(tel +61 6 249 9758 or fax +61 6 249 9970).

MEMBERS MOVEMENTS and NEW ADDRESSES

(please send in details to keep our lists current)

CHANGE OF ADDRESS

Peter BEST
Hard Rock Services, PO Box 213, Willetton, WA, 6155
email: 100353.416@compuserve.com

John HARMAN
Water Management Consultants, Perth
tel: (09) 380 8346 fax: (09) 380 8347

LOST MEMBERS

If you change you address or other details, please inform the Secretary Rob Ellis, as we wish to develop an accurate and updated membership list.

NEW MEMBERS

We are pleased to welcome the following new members recently accepted into the IAH. Congratulations.

Burton, Samuel	WA	Dickinson, Chris	QLD
Donovan, David	QLD	Hill, Clem	QLD
Jankowski, Jerzy	NSW	Kayaalp, Ahmet	SA
Lach, Anna	VIC	Logan, Sandra	QLD
McCartney, John	Peru	Moore, Michael	NSW
Morphet, Robert	QLD	Murphy, Sean	QLD
Piscopo, Genaro	NSW	Rumpf, Christopher	NSW
Steele, Adrian	WA	West, Adam	QLD
Wilkes, Shane	WA	Yesertener, Dr C	WA (ex Turkey)

PLEASE BE SURE YOUR FEES AND ADDRESS/CONTACTS ARE UP TO DATE