

Terrorists and Ground Water: Is Weaponization Possible?

by Michael E. Campana, past AGWSE chair

In the days since September 11, 2001, much discussion and work has been devoted to the issue of the protection of water supplies from terrorist attack. A quick search on Google indicated some of the organizations involved in this effort: the U.S. Environmental Protection Agency, Department of Homeland Security, American Water Works Association, Association of Metropolitan Water Agencies, Federal Emergency Management Agency, Department of Energy, Sandia National Laboratories, and even NGWA. There also are Web sites (e.g., Meinhardt, 2003) devoted to educating health-care professionals about the threat to water supplies from chemical, biological, and radiologic (CBR) agents.

Most of the concern for water terrorism has rightly emphasized the protection of water intakes and other entry points into water distribution systems and the development of emergency supplies and response procedures. The contamination of reservoirs is generally considered difficult because of the large volumes of water involved and the resulting significant dilution. For example, Danneels (2001) reported that most storage tanks for large municipal systems range from about 3 million to 30 million gallons. He also noted that it would take four dump-truck loads of sodium cyanide mixed in 1 million gallons of water to produce a lethal dose to anyone drinking the water. So it is obvious that a huge amount of a chemical toxin might be required to contaminate a storage tank or reservoir.

However, one can argue that more toxic substances than cyanide exist—for example, biotoxins, which can be lethal at the nanogram exposure level and are some of the most toxic substances known to humankind (Meinhardt, 2003, Section 5). Although biowarfare agents are generally aerosolized, Meinhardt (2003, Section 5) reported that many biotoxins are stable in water and do not produce readily detectable changes in the physical characteristics of the water.

But what about the intentional introduction of a CBR agent into an aquifer, so as to cause a large number of deaths? At first glance, this appears so ridiculous as to promote immediate dismissal of the concept. If the contamination of a reservoir or storage tank with a lethal dose of a CBR agent is difficult to accomplish, then what about aquifers, whose volumes are often measured in the millions of acre feet? But perhaps a biotoxin might prove more appropriate than a chemical. Let's assume for the moment that a terrorist organization is considering the biotoxic (chlorine resistant, of course) contamination of a municipal ground water supply through an aquifer. What kind of aquifer should they seek? How about an aquifer that (1) has recharge areas that are well known and accessible; (2) has short travel times (days or weeks) from a recharge area to a supply well; (3) provides little opportunity for a toxin to disperse, sorb, react, or degrade; and (4) has a relatively low storage volume between the recharge area and well.

Aquifers with the aforementioned characteristics exist: karst, fractured

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rock, and volcanic aquifers. Recall the tragedy in Walkerton, Ontario, in 2000, where *E. coli* O157:H7 contamination in ground water caused seven deaths and an estimated 2300 serious illnesses (Hrudey et al., 2002). The aquifer involved was a fractured, likely karstified, carbonate aquifer (Worthington, 2002). Travel times from recharge areas to wells in such aquifers can be on the order of days, and, depending upon the rock matrix, little opportunity for toxin dilution might exist through matrix diffusion. But storage volumes might be large.



Chair's Corner

by Vicki Kretsinger, AGWSE division chair
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Greetings!

By all accounts, the first Ground Water Summit was a resounding success. Just one month ago, more than 400 attendees gathered, toured, learned, networked, honored our colleagues, mentored and encouraged students, visited with long-time friends and made new ones, and enjoyed San Antonio's atmosphere and Riverwalk Fiesta celebration. Again, many thanks are extended to all sponsors, exhibitors, individuals, and organizations that supported, organized, and participated in this event. Special thanks are extended to Brent Murray, AGWSE board member and Summit chair, who captures the success of the Summit in his article in this issue of *Ground Water News & Views* (GWNV). This issue also contains several other articles that highlight activities occurring at the 2005 Summit.

There are many ways to measure whether an event is successful. The AGWSE board especially appreciated the positive on-the-spot feedback received from attendees. Another sign of a successful event is the "buzz" of energy that carries forward from one event to the planning of the next. Within 48 hours of the 2005 Summit, enthusiasm echoed across the Internet with planning ideas for 2006. We're off to a great start for next year! At the helm for the 2006 Summit are AGWSE board members John Jansen and Richard Laton.

During my welcoming comments to the Summit general assembly, I concluded by remarking that we have entered an era where we should "embrace a spirit of collaboration among disciplines and among divisions." Last year, in the September AGWSE *Newszine*, I encouraged members to share examples of the industry working together and ways to further cooperative efforts and information exchange among divisions.

Working together is a critical strength and was evidenced in the objectives set forth during the formative years of NGWA, known at the time as the National Water Well Association (NWWA). NWWA's first president, William McEllhiney, was both an engineer and contractor and advocated the importance of close cooperation between drilling contractors and scientists. He possessed a wide breadth of knowledge of drilling methods, water systems, geology, and business and recognized the importance of these contributions to the ground water industry. He actively listened to others, particularly Carl Bays (a geologist who headed the Groundwater Geology and Geophysical Exploration Division of the Illinois State Geological Survey) and Robert Storm (a geologist with the Illinois Survey who became the editor of the publication *The Illinois Well Driller*, which later became NGWA's *Water Well Journal*). Interactions between the contractors and Illinois Survey scientists (including McEllhiney, Bays, and Storm) cultivated a cooperative spirit. As one of NWWA's founders, McEllhiney envisioned the value of a large group united together to serve as a voice for the industry. Working together with others who also foresaw the need for an association to serve the entire industry, an interim NWWA board of directors was established in 1948. NGWA has since hallmarked McEllhiney's leadership through the ongoing McEllhiney Lecture Series.

Let's now fast forward to the present, where a spirit of cooperation retains its perpetual significance. In an article in this issue, Bev Herzog, AGWSE secretary/treasurer, provides an excellent example of "AGWSE and Contractors: Learning from Each Other." Bev's article illustrates the enormous potential for mutual value when scientists and con-

tractors combine their contributions toward accomplishment of a common objective. Beginning with Bev's article, and to spotlight future collaborative activities, we added a new standing column to GWNV titled "Collaboration Works." Notably, cooperative activities that merge ground water interests on common ground can also lead to long-term public benefit.

What role will collaboration play in NGWA's future? In 1991, NGWA's delegates made a determined decision to change the organization's name from NWWA to NGWA. This act recognized the importance of all aspects of ground water to the industry. Correspondingly, in 2003 and again in 2004, NGWA's surveyed membership voted on sustainability as one of the organization's primary public policy interests. In 2003, NGWA developed "Ground Water Sustainability: A Call to Action" that emphasized the essential nature of ground water resources and called for strategies to promote sustainability.

More than 50 years ago, including during the formative years of NGWA, ground water was often viewed as an economic commodity. Today, this view is balanced with the recognition that ground water resources are vital for future generations. Consequently, ground water resources have evolved in the broadest view from being a commodity to attaining greater recognition as an essential resource. NGWA is undergoing a similar transition where strategies toward sustainable ground water resources are being advocated by the ground water industry. In light of this transition, I believe NGWA's future members will seek opportunities to work in unison to communicate the importance of ground water. If NGWA embraces collaboration among the entire ground water industry in practice, an evolution of its traditional structure to one that reflects an industry united to deliver a common message would be a logical step toward an enduring legacy of an organization that represents the essence of ground water. I encourage you to submit examples of how working with other ground water professionals from other divisions and disciplines to address common objectives resulted in more effective problem resolution and better results.

2005 Ground Water Summit Highlights

The Summit of All Conferences

by Brent Murray, 2005 Ground Water Summit chair

A Texas-sized thank you to all who made the 2005 Ground Water Summit a success! Our expectations were exceeded in so many ways. The attendance of more than 400 ground water scientists and engineers from around the world was remarkable. The exploration of sinkhole caves, artesian wells and springs upwelling crystal clear water from the Edwards aquifer, and the study of recharge zones and aquifer storage and recovery projects made the field trips on Sunday, sponsored by the San Antonio Water System and the Edwards Aquifer Authority, a real treat. The Sunday short course on managing ground water data was also excellent, as I was told from several attendees.

There were plenty of opportunities for networking at this year's Summit. The icebreaker reception on Sunday night led the way to numerous other events at the Summit that focused on bringing attendees together in an atmosphere that promoted friendship, exchange of ideas, and opportunities to discuss future work possibilities. A job opportunities board was posted throughout the conference, allowing additional networking to take place.

Monday's events were kicked off by a lively keynote address on the "Politics of Oil and Water" by T. Boone Pickens. Following the keynote, the exhibit hall was open for business by our fine list of exhibitors and the platform presentations were under way. The conveners and speakers at this year's Summit reads like the who's who in ground water science and engineering. We were fortunate

to have who I consider the "legends" in our field attend and participate in this truly global assembly. The sessions were absolutely stellar and well attended until the conclusion of the Summit on Wednesday afternoon. The AGWSE Award, Darcy Lecture, and Darcy Forum on Monday were standing room only and intensely interesting. Poster presentations, highlighting truly cutting edge work, were held throughout the Summit.

The student involvement in this year's Summit was something I have not seen at other conferences. Dozens of students — our next generation of ground water scientists and engineers — were involved in either platform or poster presentations or volunteering to help NGWA staff with conference details. The student mentoring luncheon on Tuesday was a great success, as seasoned professionals shared their views on future work opportunities with a full to capacity room of students. Thank you to all of our student mentors!

Tuesday's Birdsall-Dreiss Lecture brought the many issues surrounding viruses and pharmaceuticals in ground water to the forefront. Tuesday also featured an inspirational message on "Overcoming Life's Crevasses" by Jim Davidson. Wednesday brought another full day of distinguished speakers, along with a book signing event.

All of the above, and the fun of Fiesta San Antonio celebrations on the world famous Riverwalk, made this year's conference one to remember. Thank you, again, for all who made this event possible, and we look

forward to seeing you back in San Antonio for the 2006 Ground Water Summit!

The First Darcy Forum: Panelists' Insights on the Societal Relevance of Ground Water Science

by Vicki Kretsinger,
AGWSE division chair

The 2005 Ground Water Summit brought a successful launch of the new Darcy Forum, which was cosponsored by the Geological Society of America's (GSA) Hydrogeology Division. Dave Rudolph, a professor at the University of Waterloo and immediate past AGWSE board member, created the concept for this new program. Over lunch at the 2004 Ground Water Expo in Las Vegas, Nevada, Rudolph, Warren Wood, chair of the Darcy Lecture Selection Committee, Jim Gibb, past AGWSE division chair, and Vicki Kretsinger, chair of the AGWSE division, explored the possibilities for the direction of the new Forum. As we visualized "Darcy on the couch," we reflected on what Darcy might have considered the new frontiers in hydrologic sciences or research that will meet future societal needs. And, thus, the topic for the first Darcy Forum became "The Relevance of Ground Water Science in Today's Society."

To address this topic, we assembled renowned panelists, each of whom provided their observations related to scientific advancements and the relevance of ground water science to society. They also offered their insights on important areas of

research, new approaches, and future societal endeavors. Forum panelists included:

- Mary Jo Baedecker, recently retired as the Chief Scientist of Hydrology at the U.S. Geological Survey Headquarters in Reston, Virginia
- William Woessner, a professor at the University of Montana and the 2005 Birdsall-Dreiss Lecturer
- Mary Anderson, a professor at the University of Wisconsin-Madison and editor-in-chief of *Ground Water*
- John Bredehoeft, president of The HydroDynamics Group, Sausalito, California.

Each panelist offered unique perspectives on the issue. Here is a brief summary of what each said.

Mary Jo Baedecker, past Darcy Lecturer

- Problem solving is a strength of the ground water profession. Presently, we have tools and techniques that exceed our ability to collect data. A key question arises, “How broadly are we willing to define hydrogeology?” The answer to this guides our contributions to the future of ground water science and to society. In the broad view, ground water science encompass all aspects of the water cycle, ecohydrologic systems, and interactions of these systems with microbial processes and the ubiquitous occurrence of chemicals (natural and man-made) in our environment.
- Climate change will have an impact; examples include change in snowmelt and runoff and surface/ground water interactions. Hydrogeologists should focus more on ecohydrology; water quantity and quality are intrinsically linked to ecologic problems. For instance, base flow affects stream function and habitat. Microbial activity in the subsurface is generally low, but it can be increased in certain settings, either unintentionally or pur-

posely (the latter being for remedial applications). A future consideration will be the role nutrients serve in microbial processes in ground water systems, including improved understanding of the connections between microbial processes and chemical and pathogen occurrence, transport, and fate.

- Emerging contaminants will play a major role in future ground water investigations, which will utilize interdisciplinary science teams, including geologists, hydrologists, biologists, chemists and microbiologists, to more proactively assess the occurrence and future implications of these compounds in the subsurface.

William Woessner, past AGWSE board member

- Assessing the occurrence, fate, and potential for exposure to and public health risk from pathogens and emerging contaminants, including household chemical products and pharmaceuticals (prescription and non-prescription), will be major future issues. Ground water professionals need interdisciplinary training, or recognition of the importance of interdisciplinary science teams, to better address these issues.
- Rural ground water issues have not received the attention needed to better understand the microbiological and chemical characteristics of shallow aquifers and individual wells that are typically not subject to coordinated water quality testing and can be affected by historical and present land uses, especially onsite septic systems.
- Future areas of research and investigation include: pathogen survival studies; inventories of pharmaceuticals, including sources and their fate and transport characteristics in ecohydrologic environments; field studies on fate and transport in different hydrogeologic settings; development of predictive models for varied hydrogeological systems

to assess transport of drugs and pathogens; and development of more reliable analytical methods that provide for separation of pathogenic and non-pathogenic organism identification and quantification and facilitate standardization of field and laboratory methods.

Mary Anderson, editor of *Ground Water*

- Future ground water research lies at the interface with other disciplines such as ecology, engineering, microbiology, and geology. Important fundamental research questions related to flow in fractured rock, including karst, remain to be answered.
- The recent theme issue of the International Association of Hydrogeologists’ *Hydrogeology Journal* (March 2005) on “The Future of Hydrogeology” provides examples of new research directions, including illustrations of interdisciplinary approaches. Published works need to highlight advances; however, researchers often get stuck on trying to create new ways to solve old problems, or they get caught up in presenting case study approaches to problems without trying to extend methodologies or pursue new ideas.
- Some hydrogeologic problems are too complex to solve; a better approach may be to focus on a better understanding of basic principles. Mainstream science should focus on practical problem solving.

John Bredehoeft, past editor of *Ground Water*

- The premise that research is inefficient with much produced for little gain (Schwartz, 2001) is essentially irrelevant to the question at hand for this Forum. We need to solve problems using our collective expertise. The main question is “How do we solve the problem?” We use our science toolbox, and we provide a service to society.
- As ground water practitioners, society has served us well, and it is time

to give something back. The future offers a wealth of opportunities for scientists to contribute their scientific and technological skills to humanitarian endeavors. An example of such an endeavor could be a team of scientists, drilling and pump contractors, manufacturers, and suppliers, who join together to provide critical services for disaster relief.

The panelists' insights inspired the audience as we peeked at the future through their perspectives. Although not planned, the Forum elicited significant common threads. AGWSE members, whether you heard these perspectives firsthand or not, should be enthused about contributions to be made to society through direct application or future research. There is much to be done. There exist enormous opportunities for future advancements; there are also clear needs to evolve our scientific and research approaches, engage in interdisciplinary problem solving, and tackle the challenges we will assuredly face at the interface between science, policy, and public health.

Following this first Forum, the Darcy Forum takes its place as an integral part of future Summit meetings, and members are encouraged to share their ideas on provocative topics for the 2006 Darcy Forum.

Don't miss the 2005 Darcy Lecturer

Dr. Kip Solomon from the Department of Geology and Geophysics at the University of Utah will be presenting the 2005 Darcy Lecture throughout the rest of the year. Hear his lecture, "Inert Gas Tracers in Ground Water" at any of the following dates this summer:

- June 7 — Hebrew University of Jerusalem
- June 8 — Ben Gurion University of the Negev
- June 10 — Israel Geological Survey, Jerusalem
- August 31 — Colorado State University

The Darcy Lecture is a program of the National Ground Water Research and Educational Foundation, made possible by a grant from NGWA.

For more information, please visit www.ngwa.org/ngwef/darcy.html#Current.

John Hem Award Presented at Ground Water Summit Conference



Allen F. Moench is the recipient of the AGWSE John Hem Excellence in Science and Engineering Award in recognition of his significant contributions to the understanding of the hydraulics of water-table aquifers and their interaction with surface water, and being one of the world leaders in pumping test interpretation for unconfined aquifers.

This award is presented by the AGWSE division of NGWA in recognition of a significant, recent (within five years) scientific or engineering contribution to the understanding of ground water. The award is presented annually for significant contribution(s) from either a single publication or a body of works.

This award was presented on Monday, April 18, during the Ground Water Summit in San Antonio, Texas.

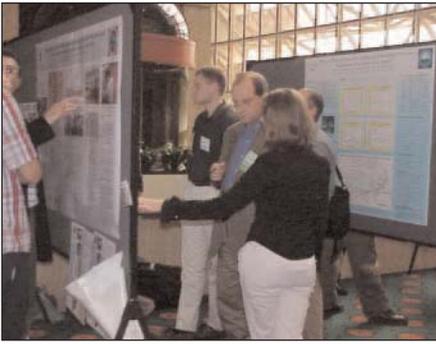
Dr. Moench received a B.S. in physics from the University of Massachusetts in 1958, an M.S. in geophysics from Penn State University in 1962, and a Ph.D. in hydrology and

water resources from the University of Arizona in 1968. He worked for the Illinois State Water Survey from 1969 to 1971. While at the Water Survey, he worked on a least-cost systems analysis for ground water pumping in the Chicago area and developed new analytical solutions for problems of well hydraulics and stream/aquifer interaction. In 1972 he worked with the U.S. Geological Survey (USGS) in Denver, Colorado. While in Denver, he worked on problems of non-isothermal heat transport in the unsaturated zone and stream/aquifer interaction. In 1975 he transferred from the USGS in Denver to the USGS in Menlo Park, California, to work on the Geothermal Program that came into existence as a result of the energy crisis of the mid-1970s. Over the duration of his career he conducted research on various problems of fluid flow and tracer transport in assorted aquifer and laboratory systems, publishing some 70 papers in the peer-reviewed literature. His primary contributions in recent years have been the development of new analytical solutions for problems of well hydraulics for unconfined aquifers.

Students Learn, Achieve, and Network at the 2005 Ground Water Summit

To promote excellence in ground water science, AGWSE has been actively working to engage more students. The 2005 Ground Water Summit in San Antonio, Texas, had two student opportunities. Students could choose to participate in the student award competition for the best poster or oral presentations and also a mentoring luncheon.

The paper/poster awards were based on three criteria: the quality of the presentation, scientific content, and respon-



ses to questions. A total of 33 students participated in the competition, which was a rousing success. Four awards, in the amount of \$250 each, were presented through the Robert Farvolden Scholarship Fund of the National Ground Water Research and Educational Foundation (NGWREF):

- Trisha B. Johnson, University of Tennessee
Paper: “Quantification of Enterovirus and Hepatitis A Virus in East Tennessee Ground Water Using Real-Time Reverse Transcription PCR”
- Benjamin K. Amos, Georgia Institute of Technology
Paper: “Improved Understanding of Microbial Reductive Dechlorination at High Tetrachloroethene (PCE) Concentrations and in the Vicinity of PCE-DNAPL”
- Amelia L. Hess, Emporia State University
Poster: “A New, Direct-Push-Based Approach for On-Site Assessment of Redox Conditions in Contaminated Aquifers”
- Amelia A. Tallman and Robyn Cook, University of Montana
Poster: “Identifying the Factors Controlling the Sources and Quantity of Water Captured by Municipal Supply Wells in the Highly Conductive Missoula Aquifer, Western Montana”

David Wunsch, AGWSE division director and Awards Committee chairman, received many remarks from attendees about the high quality of the student papers presented at the conference. “We were pleased to see so many students with great enthusiasm for ground water science participate in the competition,”

Wunsch said. The judges were Wunsch and Beverly Herzog, AGWSE division directors and NGWA members Don Keefer, Kelly Warner, and Steve Wilson. Congratulations to the winners and to all students who participated!



Students were also invited to attend a mentoring luncheon when four professionals gave presentations highlighting their views on opportunities and methods for entry into the ground water industry. Other professionals were invited to sit amongst the students for lively table conversation prior to and after the presentations. About 45 students registered for the Summit, so the luncheon was at capacity. Professionals also were encouraged to post available jobs and students had the opportunity to post their resumes. Based on the comments received, it was recommended that NGWA should conduct more mentoring activities such as these with students.

GRA — Associated State Society of NGWA

Cosponsors Summit Session
and Publishes California
Ground Water Management
Book

by Vicki Kretsinger, AGWSE
division chair

The Groundwater Resources Association of California (GRA), an associated state society of NGWA, recently cosponsored a session

at the 2005 Ground Water Summit. This session, “Ground Water Law, Policy, and the Tragedy of the Commons: The Obstacles and Some Possible Solutions to Sustainable Ground Water Management in the Southwest,” described efforts needed to integrate science with policymaking to mitigate consequences associated with an incomplete understanding of water resources systems. The session also highlighted issues related to long-term water resources availability, and presenters discussed potential approaches to address these issues and overcome obstacles to sustainable ground water management.

Fittingly, about one week before the Summit, GRA’s *California Groundwater Management, Second Edition* (2005) was published; this edition is available both through GRA at www.grac.org and at NGWA’s bookstore. California along with other states, particularly those in the Southwest, are encountering increasingly complex water management issues. As captured by the authors of the second edition, “The increasing demand for water has focused attention on improving ground water management in California. But management of ground water is complex. It involves court decisions, some statutory law, overlying landowners’ rights to ground water, complex technical issues and more than a century of political and institutional development and investment.” California uses more ground water than any other state in the nation. Tom Johnson, GRA’s president, notes, “To initiate a greater understanding of the latest ground water management issues and practices, and the critical role of ground water in California’s overall water resources plan, GRA commenced a comprehensive update of its book (initially published in 1997).”

GRA’s book is designed to provide public officials, water district directors, managers and staff, city and county planning managers, geologists, engineers, attorneys, farmers, agricultural water users, and anyone in a ground water basin who might be affected by a management plan with current information on the complexities of California’s ground water management, examples, and suggestions for workable solutions. It has also been developed as a reference material for peo-

ple that have a general interest in ground water.

Reviewers of the pre-print of the second edition have the following comments. According to Michael Campana, past chair of the AGWSE division and Albert & Mary Jane Black Professor of Hydrogeology at the University of New Mexico, "*California Groundwater Management* is an excellent resource that will

Submit an Article to GWNV!

NGWA is now taking article submissions for the next issue of GWNV in November. Articles should focus on new developments in the ground water industry, new policies or guidelines affecting our members, legislative updates or international activities affecting the ground water industry, and "best practices" in the field. Articles examining industry-related issues are of particular interest. All submissions should be about 500 words and be sent to GWNV's Technical Editor Dawn Kaback at dkaback@geomatrix.com. Is there a ground water-related topic you'd like us to cover in an upcoming GWNV? Send your ideas to NGWA's Associate Editor Jennifer Strawn at jstrawn@ngwa.org.

Wanted: Your Feedback

Ground Water News & Views, the bi-yearly newsletter for NGWA's Association of Ground Water Scientists and Engineers, wants your feedback. Do you love what you see? Or, do you think we need to improve on content, design, etc.? Then let us know! We look forward to any and all comments. Send your opinions to Jennifer Strawn at jstrawn@ngwa.org.

find wide acceptance, not only in California but elsewhere as well." David K. Todd, professor emeritus of civil engineering, University of California, Berkeley, indicates, "The second edition of *California Groundwater Management* published by the Groundwater Resources Association of California provides an indispensable guidebook for organizations and agencies desiring to provide a sustainable water supply from ground water resources. Except for institutional and legislative actions unique to California, most of the book is generally applicable elsewhere and therefore deserves wide national attention by all personnel concerned with this increasingly important water source." The early distribution of 800 copies of the second edition in California and other states reflects the widespread interest in state and national ground water resources availability and management of those resources for future sustainability.

For more information on becoming an associated state society of NGWA please visit www.ngwa.org/associatedstates/associatedstates.cfm.

IAH-Cosponsored Education Session at the Ground Water Summit: Learning by Doing Is Fun!

by John E. Moore, IAH Commission on Education and Training chair

The U.S. National Chapter of the International Association of Hydro-geologists (IAH) and the Geological Society of America (GSA) cosponsored an informative and thought-provoking

session on "Groundwater Education: Field vs. Classroom" at the 2005 Ground Water Summit in San Antonio, Texas. This session, co-convened by Richard Laton of the California State University at Fullerton, Vicki Remenda of Queen's University, and Alan Dutton of the University of Texas, San Antonio, included presentations on innovative methods instructors have developed to engage students in active learning. Such approaches, whether in the field or the classroom, stimulate students' enthusiasm for learning "by doing" and increase their ability to synthesize many forms of information as they tackle educational and research problems. Through this active process, knowledge-based skills are enhanced, and problems are more often approached with an atmosphere of intrigue and discovery. Essentially, learning is fun! Most importantly, an interactive learning environment creates a basis where the desire to learn, grow, and develop a passion for geoscience can last a lifetime.

Dr. John Moore, chair of the IAH Education and Training Commission (E&T Commission), presented information on the commission, which was established in 1993 by IAH and has 3500 members in 135 countries. The E&T Commission provides training tools targeted for teachers and the general public.

It prepares training guides to promote wise management and protection of ground water. In 1995, the American Geological Institute (AGI) published the first IAH guide, *Groundwater: A Primer*." This guide is available in four languages, including Spanish, French, and Italian. The *Glossary of Hydrology*, a handy reference for all ground water professionals, was published in 1998 by AGI. A third publication, *A Geologic and Hydrologic Guide for Peaceful Valley Scout Ranch, Colorado* (2002), was developed to educate and interest Boy Scouts in geology and hydrology. The Peaceful Valley Scout Ranch provides a terrific outdoor

The E&T Commission has sponsored hydrogeologic short courses in Mexico, Egypt, Argentina, Australia, Germany, Serbia, and the United States. Short courses also are planned for the 2006 IAH Congress in China. The commission is also preparing a series of two-page fact sheets on ground water-related topics, including locating water supplies, well contamination, spring contamination, and septic systems.

educational setting with a wide variety of rocks (including surface exposures of conglomerate and arkosic sandstone), minerals, and fossils. The guide includes color photographs of the rocks and fossils found at the ranch to aid the Scouts in understanding the local geologic features. Similar Boy Scout guides are being prepared for other Scout ranches, including the Philmont Scout Ranch in Cimarron, New Mexico, and ranches in South Africa, Spain, Portugal, and Germany.

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Those interested in the activities of the E&T Commission, or in becoming a member of the commission, can contact John Moore at *Moore123@aol.com*. Additional information on IAH is posted at *www.iah.org*.

Terrorists and Ground Water: Is Weaponization Possible?

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Let's say we have a karst aquifer with a single conduit between a recharge area (sinkhole) and production well 2 km away. The cross-sectional area of the conduit is 5 m². The total volume of the conduit between the sinkhole and the production well is 10⁴ m³ or over 2.6 million gallons. In terms of mass, this is 10¹⁰ grams of water. For a biotoxin lethal at the nanogram level, 100 grams might produce a lethal dose. And, in a karst aquifer, a travel time of a couple of days for 2 km is not unheard of, so the upshot might be a public health disaster with virtually no warning.

The above case is highly idealized and simplified. But it is a believable enough scenario that certainly warrants investigation. And remember, a credible threat from a terrorist organization would produce no fatalities, but could induce panic. An admittedly brief Internet search did turn up some work in ground water, but mainly from the standpoint of the contamination of distribution systems. I found no specific cases of people concerned with toxins purposely introduced into aquifers by terrorists. My limited research suggests that biotoxins might be the weapon of choice.

My recommendations are that (1) existing CBR toxins suitable for introduction into aquifers be identified and thoroughly investigated as to their toxic-

ity and viability in the subsurface aqueous environment; (2) emerging toxins be identified and isolated; (3) aquifer characteristics vis-à-vis CBR vulnerability be identified; and (4) susceptible aquifers and water supply systems be identified and steps taken to ensure security. With regard to the first recommendation, the substantial research performed on virus and bacteria fate and transport in porous media would no doubt prove beneficial.

Could terrorists contaminate some of our aquifers with lethal doses of CBR agents? Recall that four years ago, few of us believed that our own commercial airliners could be used as weapons. The events of September 11, 2001, should have taught us to expect the unexpected. We need to be vigilant about all our water supplies, not just those we can see.

(Note: the author would appreciate comments on this article, as well as an indication of interest about assembling a session on this topic at the 2006 Summit. Email him at *aquadoc@unm.edu*.)

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January 2005 Theis Conference

Environmental Decision Making: Restoration versus Risk Reduction

by Dawn Kaback, January 2005 Theis Conference co-convenor

In January 2005, more than 50 scientists, engineers, and attorneys met in Sedona, Arizona, to discuss “Environmental Decision Making: Restoration versus Risk Reduction” in a Theis Conference venue. Participants spent approximately three days together meeting, eating and drinking, and having fun. The beautiful setting for the conference combined with the intimate nature of the conference made for a fabulous experience truly enjoyed by all! The conference convenors were Dr. Michael Kavanaugh, Malcolm Pirnie; Eugene Lucero, Equire, Latham, and Watkins; and Dr. Dawn Kaback, Geomatrix Consultants. Dr. Bill Ball, Johns Hopkins University, provided a stellar beginning to the conference through presentation of “Coping with Complexity: Remediation, Risk Reduction, and Restoration in the Face of Uncertainty and Impracticability.”

Six half-day sessions covered the following topics:

- Risk reduction versus restoration case studies
- Hydrogeologic/engineering tools
- Economic tools
- Technical impracticability and uncertainty
- Institutional issues
- Stakeholders and risk communication.

The conference wrap-up, prepared by the convenors, identified a number of key points that were discussed throughout the conference:

- Environmental decision making involves the intersection of science, engineering, economics, and politics.
- Remediation is now a mature field:
 - More than 20 years of experience has allowed us to appreciate the complexities and uncertainties.
 - Complex sites are the norm and every site has unique challenges.
 - Science and technology have made significant advances.
 - Currently there is limited new research and development; technical advances could help to reduce uncertainties.
 - Few sites have been cleaned up, but much has been accomplished.
- The decision process is subject to many different influences:
 - There are many stakeholders with different values and goals.
 - Risk communication is difficult and requires special expertise.
 - Legal requirements often influence technical explanations.
 - Threat of litigation is real.
 - Improved communication and building of trust can improve decision making.
- New directions in decision making include:
 - Economic tools to justify decisions
 - Decision analysis tools
 - TRIAD/Adaptive Site Management.

The response of Charlie Andrews from Papadopoulos and Associates to Mike Kavanaugh’s question in the closing session, “What is the problem?” was “In general, reasonable remedies have been and are being implemented and sites are being closed.” He also suggested that approaches such as TRIAD are



Some of the Theis participants taking a break in Sedona, Arizona.

being implemented, accepted by the regulatory community, and should continue to be encouraged. He stated that although few technical impracticability waivers have been granted in the U.S., he believes the concept of technical impracticability has been recognized by most regulators and is being incorporated into RODs without a formal waiver.

One of Dr. Andrews' recommendations was to support continued research on ways to expedite ground water cleanups. As recommended in the National Research Council report in 1994 on ground water cleanup, the use of an "infeasibility fee" to fund research was recommended, and he believes this is still a useful recommendation. Brad Call from the U.S. Army Corps of Engineers recommended that additional study on management of uncertainty be conducted. Other recommendations, which might involve conduct of studies or conferences, included:

- a comprehensive analysis of performance of remedial systems in a variety of settings
- better communication of advances in technology and policy
- more training in a variety of areas including risk communication
- more pragmatism and credibility
- how to do risk-based decision making within the RCRA/CERCLA framework
- recognition of long-term stewardship issues
- better definitions of closure or completion.

Overall, the conference engendered much discussion and camaraderie regarding a timely topic with a look as to how we can do a better job in the future.

Deadline for Call for Participation Extended

Did you miss the deadline for the 2005 September This Conference? The Call for Participation has been extended to May 31. The September This Conference, September 23-26, in Lake Tahoe, Nevada, will convene ground water researchers, regulators, and professionals for discussion of (1) state-of-the-art methods for estimating ground water age through the use of environmental tracers, emphasizing, but not limited to, the 0-to 50-year timescale; (2) state-of-the-art methods for modeling ground water age, age dispersion, and related transport phenomena; and (3) application of these methods to address current problems such as ground water vulnerability, sustainability and restoration of ground water quality, and consequences of ground water storage and recovery projects for ground water quality.

Calls for Abstracts

June is the deadline for the Calls for Abstracts for two upcoming NGWA conferences: the FOCUS Conference on Eastern Water Issues in Portland, Maine, and the Remediation Conference in New Orleans, Louisiana.

FOCUS Conference on Eastern Water Issues

Abstracts on the following topics are due June 1 for the conference in Portland, Maine, September 26-27. Extended abstracts (up to five pages) are due August 15. More information on formats, deadlines, and topics can be found at www.ngwa.org/pdf/e/conf/0509265081cfp.pdf. The topics include:

- Arsenic, radon, radium, and other naturally occurring contaminants
- DNAPL remediation
- Remediation in fractured rock
- Fractured rock characterization
- Glacial drift hydrology
- Coastal hydrology
- Aquifer storage and recovery projects

- Bottled water projects
- Surface and borehole geophysics
- Integrating characterization methods
- Aquifer testing-well testing
- Drilling techniques
- Reactive transport modeling
- Isotopes and tracer tests
- Source water assessment and delineation
- Landfills: design, monitoring, and remediation
- Technical impracticability at remediation sites
- Blasting and hydraulic fracturing-case studies and policy issues
- Individual homeowner wells.

Remediation Conference

Abstracts are due June 7 for the conference in New Orleans, Louisiana, November 7-8. More information on deadlines, format, and topics can be found at www.ngwa.org/pdf/e/conf/0511075010cfp.pgf.

NGWA in Washington

Nation's Largest Source of Fresh Water—Ground Water—Needs More Study, NGWA Tells U.S. Senate Committee

by Chris Reimer, NGWA Government Affairs director

In considering the nation's increasing demand for water, the federal government should support efforts to study the largest source of available fresh water—ground water—NGWA said April 5 in testimony before the U.S. Senate Energy and Natural Resources Committee.

Although ground water makes up roughly 95% of the earth's fresh water supply, "Few states have sufficient infor-

mation necessary to adequately understand the potential yield of their aquifers," NGWA member David Wunsch told the committee.

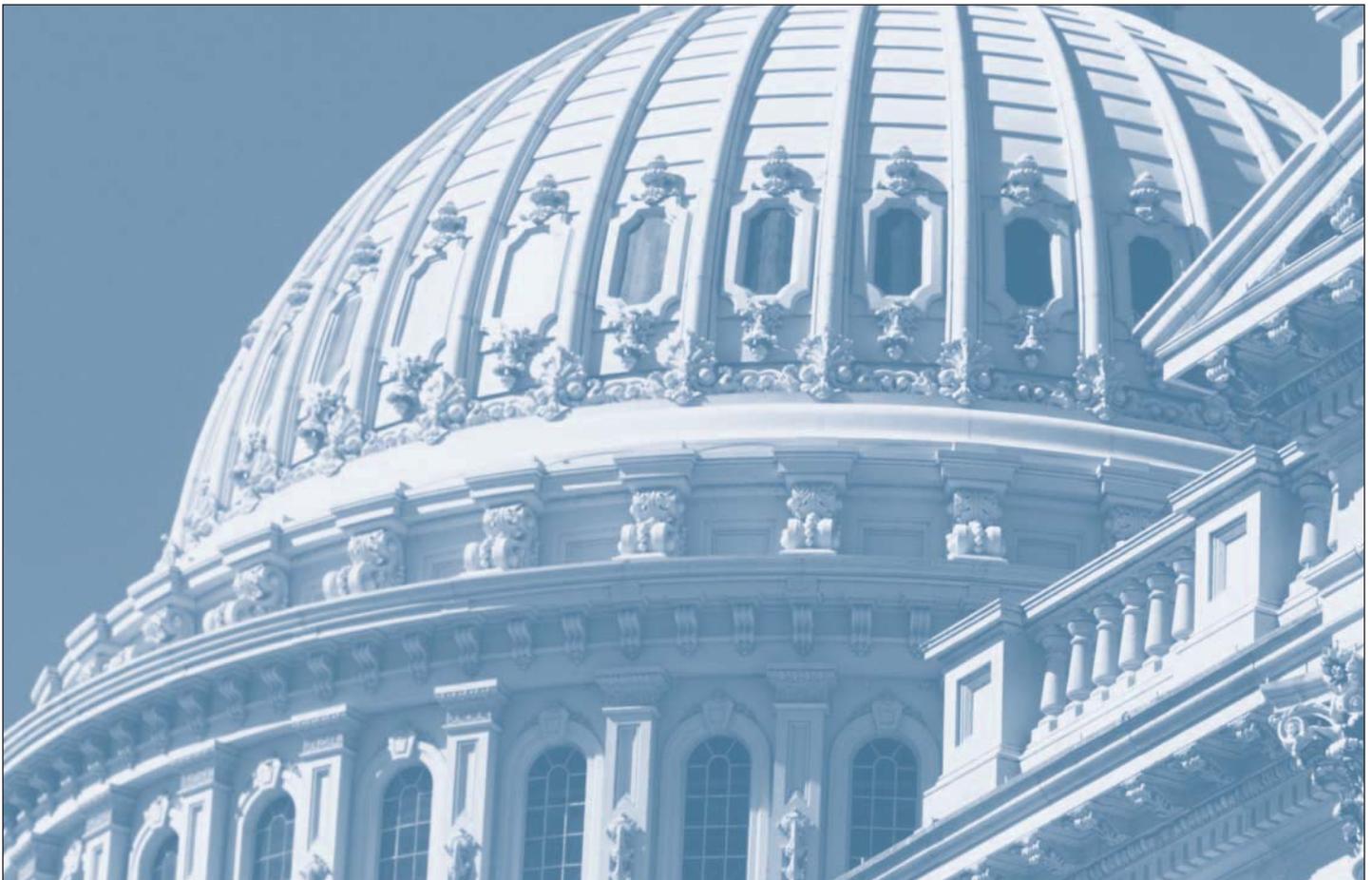
NGWA was among 22 groups selected by the Senate committee to present and discuss their proposed solutions to the challenges of meeting the nation's ever-increasing demand for water at a half-day Bipartisan Water Conference. NGWA was

chosen to speak on the topic "Knowledge of Water Resources."

In a survey of 28 states, NGWA identified increased federal funding for cooperative ground water quantity and quality data collection and aquifer mapping as the most useful actions the federal government could take. "NGWA members consistently stated that the most useful and efficient action the federal government could take would be to increase federal funding for cooperative ground water programs and data collection," Wunsch said. The National Cooperative Geological Mapping Program was given as a good example of a successful program.

Specific activities meriting additional discussion include:

- **Data Gaps.** There is a need for a national clearinghouse for ground water information and data, including real-time data, to help maximize everyone's data-gathering efforts.
- **Research Priority Areas.** Top priorities for development of long-term ground water sustainability plans



include research on water reuse and conservation, alternative treatment systems, development of brackish ground water supplies, aquifer storage and recovery or artificial recharge, emerging contaminants and the development of remediation technologies, and the development of models and data standards.

- **Education.** We need to educate the public nationwide so they will understand the urgent need for exercising responsible water use.

“No study of our nation’s water supplies can be complete without a clearer picture of our ground water resources. One key to success is a vigorous federal role in funding cooperative efforts with state and local governments to address data gaps,” Wunsch said.

Besides Congressional members, White House staff also sought NGWA’s input on a series of questions regarding the federal role in ground water monitoring and research related to water availability. The questions come on the heels of a recent White House report on fresh water availability.

The April 18-20 NGWA Ground Water Summit was the venue for work groups, representing NGWA’s diverse membership, to draft initial responses.

The discussion was lively and informative. Conclusions mirrored many of the themes in earlier NGWA member surveys. There was strong agreement on the need for additional ground water data and information. A clearinghouse to organize, collect, and make accessible current and future ground water data was seen as an integral part of maximizing data gathering efforts. Members envision an integrated approach to monitoring with federal, state, and local governments along with the private sector collaborating in developing and operating a national ground water quality monitoring network and a national ground water level monitoring network.

The second series of White House questions on federal research focused on brackish ground water and desalination issues. With data lacking regarding the

nation’s fresh ground water supply, even less is known about the extent and potential for brackish ground water treatment and use. The work group identified priorities for federal research related to brackish ground water use, desalination, ground water recharge, and aquifer storage and recovery. The drafts go to NGWA’s Regional Ground Water Management Task Force for review.

In April, Congressman John Linder’s bill, HR 315, passed the House. The bill would establish a National Commission to review and recommend a national water policy. The legislation was referred to the Senate Environment and Public Works Committee. NGWA and ground water professionals are in key positions to assist at the federal, state, and local level as questions arise regarding the nation’s water supply.

Thank you to the following individuals who participated in the NGWA work groups:

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The HydroDynamics Group
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Kingsville, Texas

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Oklahoma City, Oklahoma

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Engineering
Kingsville, Texas

David Wunsch, Ph.D.
New Hampshire Geological Survey
Concord, New Hampshire

The National Ground Water Association thanks these professionals for sharing their scientific and technical expertise. The document reflects their collective input as ground water professionals, and does not necessarily state or reflect the views of their employers.

International Water Issues

NGWA Promotes International Outreach at CARA and IANAS Meetings

by Kevin McCray, NGWA executive director

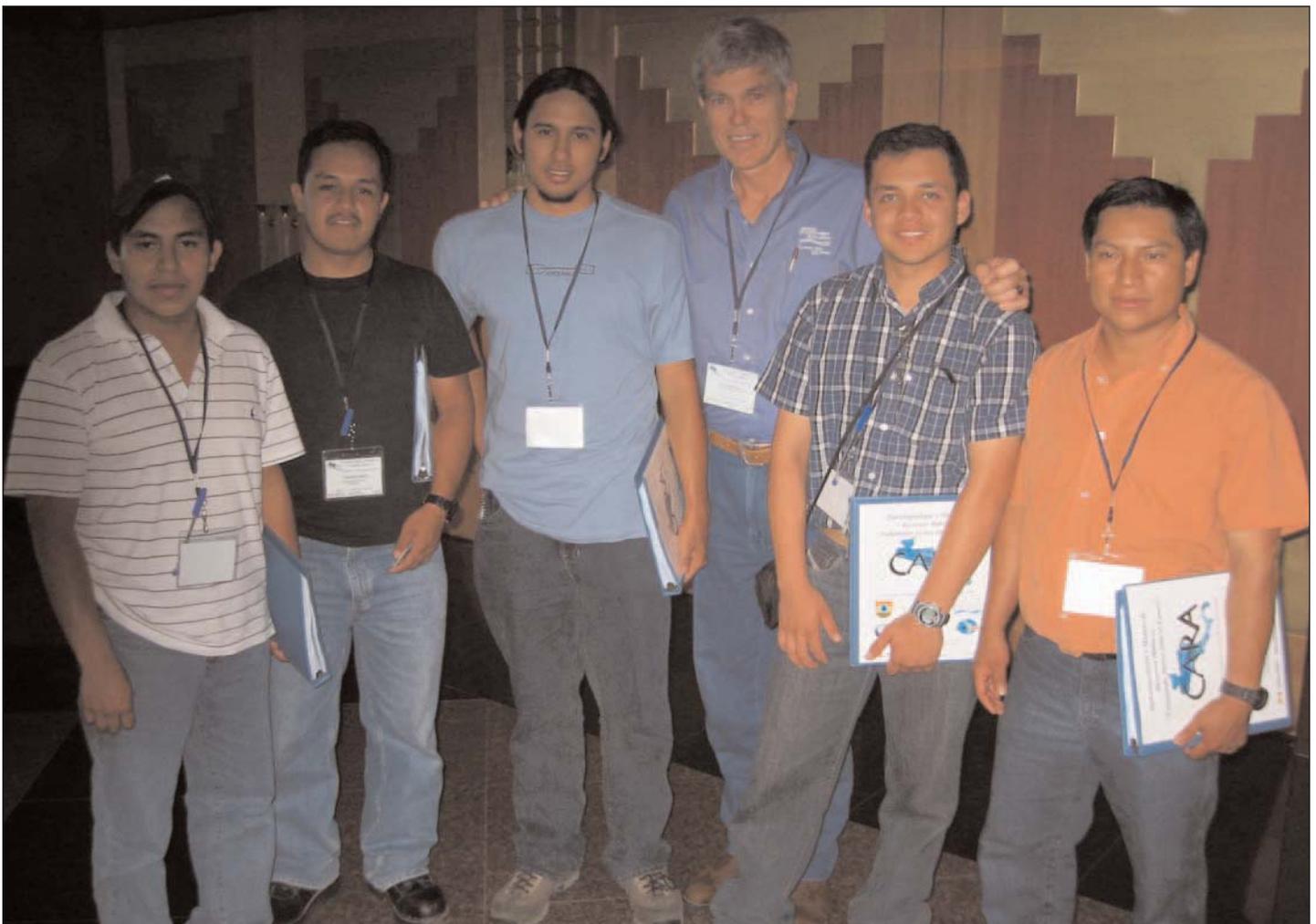
Central American Water Resource Management Conference, Managua, Nicaragua

Approximately 192 hydrogeology students, faculty, and others, including representatives of NGWA, gathered at Managua, Nicaragua, March 7-11, for the Fifth Congress of the Central American Water Resource Management Network (CARA). CARA's mandate has been to

improve Central Americans' capacity to manage their water resources through the development of water management master's programs at three Central American universities: the University of Costa Rica, the National Autonomous University of Nicaragua, and the University of San Carlos of Guatemala. CARA has been assisted in its initial efforts by the Canadian International Development

Agency's Universities and Colleges Program office, and specifically, water-resource related faculties at the University of Calgary and the University of Waterloo. Several NGWA members, including former AGWSE division director Dr. Dave Rudolph, Dr. Ramón Llamas, and Dr. Emilio Custodio of Spain, were also in attendance.

As ground water is estimated to be the potable water supply for about 80% of Central Americans, NGWA was a cosponsor of the event and was represented by Executive Director Kevin McCray. Joining McCray was member Ralph Cadwallader, a ground water contractor from Texas, who at the invitation of CARA officials gave a workshop on water well construction technologies to the 52 master's students in attendance. Cadwallader, who lived for a number of years in Guatemala, made his presentation in Spanish and distributed reprints of significant well construction articles from the annual Spanish-language editions of the Association's *Water Well Journal*, which were published in the 1980s. In addition to a bilingual presentation about





Luis Marín and José Galicia Tundisi, co-chairs of the IANAS Water Program in Bogotá, Colombia.

the Association's international outreach efforts and benefits of membership, NGWA provided copies of its two science journals to the registrants and distributed Spanish-language materials about NGWA, as well as materials about professional development opportunities available from the Association.

Cadwallader and McCray found the enthusiasm and professionalism of the students so encouraging that they teamed up to personally donate to CARA 30 one-year student memberships in the AGWSE division of the Association.

"We are hoping to educate and motivate these young people to take leadership in the ground water sector," says David Bethune, the CARA project manager at the University of Calgary. "These young hydrogeologists need to understand the issues and importance of them working very closely to develop and educate the ground water contractors of their countries." Bethune says there are presently less than a handful of ground water scientists in each of the Central American nations, underscoring the importance of the CARA initiative and NGWA's involvement to help nurture a growing base of scientific and professional capacity.

Katherine Vammen, the CARA team leader from the Universidad Nacional Autónoma de Nicaragua (UNAN), explained that now after five years of support from the Canadian national government, the program is expected to become self-sufficient. The uni-

versities are seeking grants to sustain the program's efforts.

Inter-American National Academies of Sciences Meeting, Bogotá, Colombia

The water program steering committee of the Inter-American National Academies of Sciences (IANAS) met at Bogotá, Colombia, March 12-13, to begin active planning of the group's ambitious efforts. NGWA was invited to participate and was represented by Executive Director Kevin McCray. Also in attendance was newly elected AGWSE division director Dr. Luis E. Marín of the National Autonomous University of Mexico (UNAM) and the Mexican Academy of Sciences. Marín, along with Dr. José G. Tundisi of the Brazilian Academy of Sciences, are the steering committee's co-organizers. The meeting was hosted at the Colombia Academy of Exact, Physical and Natural Sciences in Bogotá.

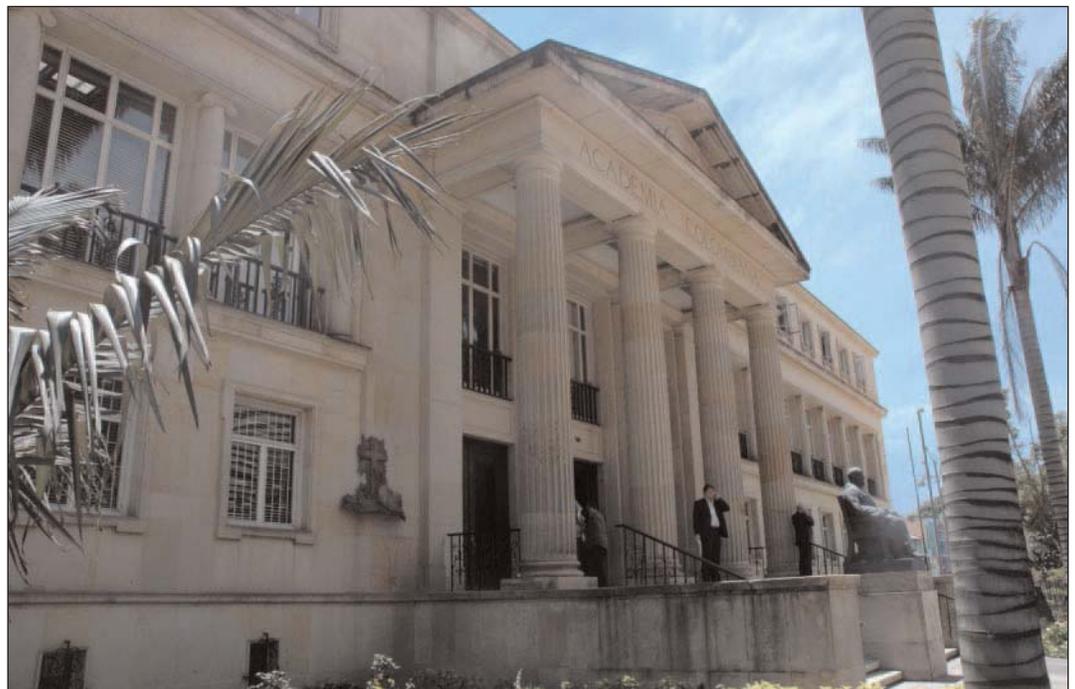
Marín and Tundisi see the IANAS water effort likely initially focusing on three broad areas: ground water, urban hydrology, and eutrophication, all with a firm underpinning in recognizing their interrelationship within the hydrologic cycle. In particular, they wish to draw attention to the legal, social, and economic factors related to these scientific topics, with an end goal of technology transfer and indigenous capacity building within Mexico,

Central America, and South America.

Representing the U.S. National Academies of Science was Dr. Henry Vaux. Other nations represented at the event were Bolivia, Canada, Chile, Colombia, Cuba, Nicaragua, and Peru. Representing the global Inter-Academies Panel (IAP) was Dr. Yves Quéré of France, the IAP's cochair.

Using examples of NGWA's diverse international outreach efforts, McCray explained the role of a professional society in assisting initiatives such as the inter-Americas water program. NGWA, along with the steering committee, is hopeful to raise the visibility in the conference program of the fourth World Water Forum being planned for early 2006 at Mexico City. As a part of this effort, a number of presentations at NGWA's 2004 Ground Water Expo in Las Vegas, Nevada, as well as planned papers at the 2005 event in Atlanta, Georgia, focus on supporting a broader ground water presence at the Forum.

"We are all very enthusiastic with the results of the Colombia meeting, and we are looking forward to get the IANAS water program to move and establish collaboration with the NGWA," says Marcos Cortesão Barnsley Scheuenstuhl of the Academia Brasileira de Ciências [Brazilian Academy of Science].



The IANAS meeting took place at the Academy of Sciences of Colombia on March 12-13.

Collaboration Works

AGWSE and Contractors: Learning from Each Other

by Bev Herzog, AGWSE board member

I attended my first Ground Water Expo in about 1980. A panel discussion on well specifications quickly turned into a debate between the contractor and the technical division (as AGWSE was called at the time). The debaters agreed that the two divisions needed to work together so that the best possible wells would be drilled and constructed.

At the 2004 Expo, I was the lone AGWSE member one evening at dinner with NGWA President Larry Lyons, several board members and some Past Presidents. Again, the subject turned to how we can work together and learn from each other. The evening ended with a suggestion that AGWSE members get more involved with their states' associations. I took that as a challenge. The Illinois State Geological Survey (ISGS) always has a booth and frequently presents workshops at the Illinois Association of Groundwater Professionals' (IAGP) annual meeting. This year, I talked with the association's Executive Director Sue Bohenstengel and said we'd like to do more than usual for the February show. We were already committed to a workshop on Global Positioning Systems (GPS), which was requested because Illinois will be requiring GPS coordinates on well logs starting next year. I suggested that we also have a live demonstration at our booth of our new online access to water well records. The drillers had been asking for this service for a long time and, at last year's

show, we promised that it would be available within six months. Although this new service already had been live for several months, ISGS wanted to make sure that drilling contractors were aware of it and comfortable using it. We were especially interested in getting their feedback. In addition to a free high-speed Internet hookup at our booth, Bohenstengel offered us a separate room with several hookups where people could spend more time online with a tutor.



Four ISGS staff members, including me, attended this year's annual meeting, which had an attendance of about 250. Tutorials on the water well records database proved to be very popular; frequently, people waited in line to use the computers. Several drillers commented that this application would induce them to learn how to use a computer or the Internet and to get an Internet hookup at their business. One driller said that the ISGS' Internet site is the only one he has ever visited, but he was considering see-

ing what else is out there. Others noted that they have been using the system daily as it helps them bid jobs. An example of how one contractor had applied the system involved a bid on a recent well disinfection job. He was the successful contractor and had the more expensive bid; however, he brought his laptop to show his prospective customer her well log, and then explained why the competitor's bid would not be as effective. Another contractor liked the site so much that he programmed the address into his PDA while at the show. During the demonstrations, we found that contractors were using the site in ways we hadn't envisioned and received suggestions that could make it even more useful.

What did the ISGS get out of this? First and foremost, we provided our constituents with services they value; this is something we believe all government agencies strive for. We want the drillers to supply higher quality logs, as these are

the basis for the geologic mapping program, and the entire ground water community relies on them for many other applications. By working with contractors, we hope to improve the utility and value of the data for everyone. Finally, we would like to know when they are drilling in an area where we are mapping so that we can log the boreholes and collect samples. This kind of cooperation improves the quality of the data generated and stored and can save the taxpayers money by decreasing the number of holes we need to drill

for our mapping program.

So, I leave you with the challenge I received last December — become more involved with your state association. As with most volunteer opportunities, you will find that you get at least as much out of it as you give. If you are already active in your state's association, please share your stories with me at herzog@isgs.uiuc.edu and I'll compile them into a follow-up story in the next *Ground Water News and Views*.

Students Corner

Geology Has Its Perks

Students Studied Costa Rica's Beaches Firsthand

by Jason Cole

The fourth-year earth sciences and geological engineering students at the University of Waterloo, many of whom are young burgeoning hydrogeologists, traveled to Costa Rica on August 30-September 11, 2004, in search of adventure, volcanoes, and oddly enough, ground water.

The trip is a part of Earth 490, an annual field course designed to give students experience in the outdoors and show us that the pictures in our textbooks actually do exist. The trip was led by University of Waterloo professors Dr. Dave Rudolph and Dr. Bob Linnen. Rudolph accompanied us on the trip, not only for his hydrogeology expertise, but because he speaks Spanish, and Bob, who is an experimental petrologist, couldn't turn down an opportunity to visit active volcanoes.

We arrived midday in San José, Costa Rica. We then traveled west to La Fortuna, the closest city to the Arenal volcano and home to magnificent La Fortuna waterfall. The following day the class was divided into two groups. One group was to climb the volcano to study lahar sequences, and the second was to climb to the bottom of the waterfall. The groups would alternate the next day.

Arenal is a stratavolcano that is currently erupting. At night you can see lava exploding from the top and house-sized volcanic bombs crashing down the mountain. We climbed to a ridge of basaltic andesite lava flows to study their properties. Unbeknownst to me, these rocks would actually make a small but good aquifer, as they are blocky and highly fractured.

Our climb to the base of the waterfall the next day was treacherous! La Fortuna waterfall pours into a deep valley with shear walls of basaltic flow deposits.

Stress fracturing caused during cooling forms columnar jointing in the basalt, which accounts for the high secondary porosity found in this rock sequence (Figure 1). Fractured pyroclastic rocks are the primary aquifers for La Fortuna and for much of the central valley region of Costa Rica. The incised valley provided us with a unique opportunity to see a giant cross-section of the primary aquifer for the region. Overlying the columnar jointed basalt is a layer of unfractured basalt and a lahar sequence. Both act as semi-confining aquitard units. Underlying the aquifer is a highly porous layer of tuff, but due to its small extent, it makes for a poor regional aquifer.

After spending two days swimming under waterfalls, examining the primary regional aquifer, and climbing a volcano,

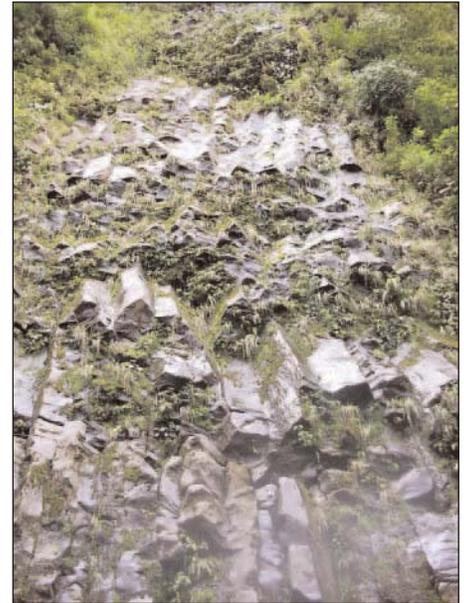


Figure 1. Columnar jointing along the walls of the valley at La Fortuna waterfall.

it was time to move on. Next stop on our tour was Liberia, Costa Rica.

Liberia is a rapidly expanding urban center and is the largest city on the Pacific side of Costa Rica. The class traveled north of the city to an area identified as the primary recharge area for the city's aquifer. Ground water resources in Liberia are derived from a complex, volcanic, multiple aquifer system that consists of tuffs and fractured lavas. Tuffs can vary greatly in their ability to trans-



Figure 2. A group photo of the geological engineers and the earth science students. Directly behind the students is a section of poorly welded tuff. Overlying the tuff is a basaltic flow deposit, which acts as an aquitard for the tuff aquifer.

mit water. Poorly welded tuffs have high primary porosity and permeability, whereas welded tuffs commonly have low primary porosity. These units can be fractured and have high secondary porosity, making them productive. As a group, we chose this area for a big group photo (Figure 2). The unwelded tuffs of the Liberia aquifer make a fantastic backdrop!

We left Liberia behind to study Costa Rican gold deposits in Juntas. Costa Rica has a small gold industry where miners independently extract and process gold by hand. Processing facilities, where the gold is removed from its host rock (using mercury), can be found in the back yards of the miners. The Workplace Safety and Insurance Board in Canada would have a field day with this place!

September 4, 2004, was the day of the big hike up the Rincon de la Vieja volcano. An 8 km hike traversing 1300 m of vertical in 30°C Costa Rican heat proved to be a great challenge. Thankfully, we all made it. The trail crawled its way over lava flows, up 80° inclines and along long, narrow talus slopes. At the top was a “dead zone” surrounding a crater lake with a pH of 0-1.

We were all in for a surprise when our bus arrived on the Nicoya Peninsula at the Barra Honda karst caves. Who knew that they had carbonate rocks in Costa Rica? Entering Barra Honda required climbing down a 30 m ladder into a room devoid of light. Our tour guides took us through a series of tiny crevasses, past huge stalactites and stalagmites, and around mammoth sheets of drapery.

The trip continued onward to the Pacific coast to closely examine the beaches — I mean bedrock sequences. Over the next couple of days we mapped rock sequences on the beach. If I had to choose the best place in the world for mapping rocks, it would be on the beaches of Costa Rica! We began by mapping an ophiolite sequence on the beach near Playa Carrillo. For anyone who forgets, an ophiolite sequence is a characteristic assemblage of rocks that formed at a spreading ridge. Next, we examined a rare, exposed synclinal and anticlinal sandstone outcrop (Figure 3).

On September 11, 2004, with our minds fully saturated with knowledge of volcanic aquifer sequences, karstic caverns, welded vs. unwelded tuffs, and our feet still sore from climbing Rincon de la Vieja, we boarded a plane to return to



Figure 3. Cole and his fellow Earth 490 classmates mapped rocks on the scenic beaches of Costa Rica.

Waterloo. The trip was an amazing experience and the knowledge and memories gained are priceless. After taking Earth 490, there is only one thing left to do, find

a master’s supervisor with a project in Costa Rica!

Jason Cole recently completed his undergraduate degree from the University of Waterloo, majoring in hydrogeology. He is set to begin a master’s program supervised by Dr. Dave Rudolph in September 2005. Unfortunately, his thesis topic is not based in Costa Rica, but he hopes that his experience will put him at the top of the list for teaching assistant positions for next year’s Earth 490 trip.

NGWA News

Honor a Fellow Ground Water Industry Professional

Do you know a seasoned volunteer or active businessperson who has gone beyond the call of duty to support ground water initiatives? Do you know of a member who has provided extraordinary leadership and insights, or a project that deserves special tribute for its innovation in supply, remediation, or ground water protection? Make sure they are honored.

You are the eyes and ears of the industry. Your nominations are vital to ensure that those leaders receive the accolades of their peers at NGWA's annual Conference and Exposition.

Nominations for this year's NGWA and AGWSE division awards are due by August 1. For more information or to download an application form, please visit www.ngwa.org/awards/awards.html.

It's Not Too Late! NGWA Extends Interest Group Abstracts Deadline

Did you want to submit an abstract for an Interest Group Session at the 2005 Ground Water Expo, but thought you had missed the deadline? Now's your chance! The deadline for abstract submissions has been extended until June 1. Topics for Interest Group Sessions are geothermal energy, ground water availability, ground water modeling, horizontal wells, Internet ground water data, microbial ground water quality, regulators, transboundary ground water, and wellhead protection. More information on these sessions can be found at www.ngwa.org/e/expo05/0512136010.shtml.

Associates Corner

NGWA Cosponsors Two Sessions at 2005 GSA Annual Meeting

by Vicki Kretsinger, AGWSE division chair

As an associated society of the Geological Society of America (GSA), NGWA will be cosponsoring two sessions at the 2005 GSA Annual Meeting and Exhibition, "Science—Learning—Colleagues," October 16-19, in Salt Lake City, Utah. Cosponsorship of these sessions by NGWA also furthers collaborative activities that benefit both organizations and is in concert with the additional alliance established when NGWA's Mutual Cooperation Agreement formalized a reciprocal partnership between NGWA and GSA in December 2004.

"Groundwater Quality and Quantity Interconnections: The Effects of Natural and Anthropogenic Contamination on Groundwater Availability," one of cosponsored sessions, is being co-con-

vened by Mike Moran from the U.S. Geological Survey (USGS) and Vicki Kretsinger from Luhdorff and Scalmanini and AGWSE Division chair. Mike is also chair of NGWA's Ground Water Availability Interest Group. This session (Topical Session T15) will focus on the interconnections between ground water quality and quantity, including the effect that quality can have on the volume of ground water that is effectively available for present and future human and ecological needs. Invited speakers presenting in this session include Graham Fogg of the University of California at Davis, Kevin Dennehy of USGS, Jean Moran of Lawrence Livermore Laboratories, and Paul Squillace of the USGS. The conveners welcome papers on topics such as understanding the vulnerability of ground

water systems to quality/quantity degradation, identifying criteria for assessing the quality/quantity of ground water, and water quality/quantity management objectives and methods for sustainability.

The other session, "Innovations and New Frontiers in Hydrologic Modeling," which is cosponsored by GSA's Hydrogeology Division, NGWA, the U.S. National Chapter of the International Association of Hydrogeologists (IAH), and GSA's Engineering Geology Division, is being organized by Frank Schwartz of Ohio State University and Motomu Ibarki of the University of Waterloo. This session (Topical Session T18) will explore how models have grown from a mathematical curiosity to an indispensable tool for analysis of hydrologic systems. This session will also examine new developments in ground water and hydrologic modeling, emphasizing innovations in theory, design, and data handling. Invited speakers presenting in this session include Ed Sudicky of the University of Waterloo, Al Woodbury of the University of Manitoba, and Zhongbo Yu of Ohio State University.

ABSTRACTS DEADLINE: JULY 12

Abstracts for these cosponsored sessions must be submitted electronically on GSA's Web site at www.geosociety.org (instructions are posted at the site) by July 12, 2005 (11:59 pm Pacific Time). Electronic abstracts will be archived and remain searchable on the site for at least two years. For further information about Topical Session T15, please contact Mike Moran at mjmoran@usgs.gov, or Vicki Kretsinger at vkretsinger@lcse.com. See also the Call for Abstracts for Session T15 posted at www.ngwa.org under the Events & Education page. For further information about Topical Session T18, please contact Frank Schwartz at frank@geology.ohio-state.edu.

NGWA Supports USGS Coalition Testimony

NGWA was one of several groups to sign testimony to the U.S. House of Representatives Committee on Appropriations prepared by the U.S. Geological Survey (USGS) Coalition requesting increased funding for the USGS. The USGS Coalition is a group of 69 organizations working together to support the biologic, geologic, and hydrologic mapping programs conducted by the USGS. By supporting these efforts, NGWA and the other coalition members were able to achieve relatively flat funding for the USGS in the 2006 federal budget. Although short of the requested 7.1% increase, the 2006 funding avoided heavy cuts that other government agencies are facing. Funding for water-related programs will remain relatively flat, while the minerals program will receive a \$29 million cut. Included in the budget is a pilot study for a new National Assessment of Water Availability and Use. The pilot study is a five-year program focusing on the Great Lakes, with the first year's budget being \$1.2 million. USGS Director Chip Groat described the proposed 2006 budget as a victory, but tempered that by also calling it a challenging victory.

In the past few years NGWA has worked with the USGS Coalition and independently used its own lobbyists to reverse several significant cuts proposed for the USGS.

Those proposed cuts were successfully turned into small increases due to these efforts. However, in light of the current fiscal situation, flat funding represents a victory. NGWA's lobbying effort to support the USGS has opened up new channels of communication to resolve some long-standing points of contention, such as competition with the private sector. We believe that the stage has been set for more cooperative relationships within the ground water community, which will lead to more and better ground water research and better stewardship of our ground water resources.

Groundwater Ambient Monitoring and Assessment Program: Increasing the Public's Knowledge of Ground Water Quality in California

In 1999, the California legislature and governor, as well as private citizens, became increasingly concerned about ground water quality. More than 8000 public supply wells had been closed since the mid-1980s due in part to the detection of chemicals, such as MTBE and solvents. In response to this need, the California State Water Resources Control Board (SWRCB) created the Groundwater Ambient Monitoring and Assessment (GAMA) Program.

California relies on ground water for up to 40% of its water supply. Monitoring is an essential part of protecting our precious ground water resources. GAMA is a voluntary, nonregulatory program designed to assess ground water quality and to better understand risks to the resource.

Priority Basin Assessments

GAMA has begun implementing its statewide priority ground water basin assessment (AB 599-Liu, Groundwater Quality Monitoring Act of 2001). The primary goals and objectives of the Priority Basin Assessments are to:

- Improve ground water quality monitoring in California.
- Make ground water information available to the public.
- Be useful at the statewide and local level.
- Provide data to make ground water assessments.

GAMA has divided the state into 35 priority basin "study units." As of March 2005, GAMA had completed sampling in three of the study units: San Diego, North San Francisco Bay, and North San Joaquin Valley. The program was set to begin sampling in the South Sacramento Valley Study Unit in March 2005.

The SWRCB is collaborating with the U.S. Geological Survey and Lawrence Livermore National Laboratory to implement the GAMA Program. Assessment reports will be posted on the GAMA Web site as they are completed.

Voluntary Domestic Well Assessment Project

The Voluntary Domestic Well Assessment Project is another important element of the GAMA Program. The GAMA Voluntary Project samples domestic wells for chemicals commonly found in private well water and provides analytical results to the well owner.

Currently, the quality of domestic well water in California is largely unknown. Domestic well sampling programs in other states have detected chemicals such as MTBE and coliform bacteria. The GAMA Voluntary Project focuses on specific areas of the state. So far, the project has sampled areas in Yuba, Sutter, El Dorado, and Amador counties. The next focus area is now in Tehama County. Summary reports will be posted on the GAMA Web site as they are completed.

Additional information on the GAMA Program is available at www.waterboards.ca.gov/gama/.

Upcoming Events

Upcoming NGWA Conferences

July

Ground Water and Environmental Law Conference

Baltimore, Maryland

July 21-22

The third NGWA conference on ground water litigation and environmental law features presentations from attorneys, consultants, and regulators covering a number of topics from current court cases to changes in regulations and the use of ground water models in the courtroom. There will also be an explanation of the combination of a number of MTBE product liability lawsuits into federal court including the *State of New Hampshire v. Amerada Hess et al.* Attendees will learn about ground water law, make contact with some of the nation's leading expert witnesses and attorneys, gain valuable information and receive a full proceedings, which can serve as a desk reference.

www.ngwa.org/e/conf/0507215066.shtml

August

Petroleum Hydrocarbons and Organic Chemicals Conference

Costa Mesa, California

August 18-19

Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Assessment, and Remediation will feature presentations on topics such as site characterization and monitoring, natural attenuation processes, and remediation technologies, to name just a few.

September

Theis Conference

Lake Tahoe, Nevada

September 23-26

The Theis Conference will convene ground water researchers, regulators, and professionals for discussion of (1) state-of-the-art methods for estimating ground water age through the use of environmental tracers, emphasizing, but not limited to, the 0-to-50-year timescale; (2) state-of-the-art methods for modeling ground water age, age dispersion, and related transport phenomena; and (3) application of these methods to address current problems such as ground water vulnerability, sustainability and restoration of ground water quality, and consequences of ground water storage and recovery projects for ground water quality.

www.ngwa.org/pdf/e/conf/0509235100cfa.pdf

FOCUS Conference on Eastern Regional Water Issues

Portland, Maine

September 26-27

Call for Abstracts for this conference is June 1. For more information, see

www.ngwa.org/pdf/e/conf/0509265081cfa.pdf

November

Remediation Conference

New Orleans, Louisiana

November 7-8

Call for Abstracts for this conference is June 7. For more information, see page 10

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NGWA Special Interest Groups

Geothermal Energy, Ground Water Availability, Ground Water Modeling, Horizontal Well, Internet Ground Water Data, Microbial Ground Water Quality, Regulators, Transboundary Aquifers, and Wellhead Protection. For more information on interest groups, including names of members, go to www.ngwa.org/sig/sig.html