HYDRO VISIONS

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Groundwater Resources Association of California

Summer 2007

Applications of Isotope Tools to Groundwater Studies Symposium Summary

MARCH 28- 29, 2007, CONCORD, CA

BY MICHAEL TARASZKI, JULIE SUEKER, MICHAEL SINGLETON, BILL MOTZER, AND JEAN MORAN

Isotopes Symposium Committee Members (shown) left to right: Jean Moran, LLNL; Bill Motzer, Todd Engineers; Carol Kendall, USGS; Alan Jeffrey, ZymaX Forensics, Stephanie Moore, D.B. Stephens & Associates, Inc., Julie Sueker, Arcadis, US, Inc. Not shown in photograph: Michael Teraszki, MACTEC; Michael Singleton, LLNL, and Eric Reichard, USGS

The use of isotopes as a tool in groundwater studies has increased significantly in recent years, as was evident by the solid attendance of this symposium. Although the use of oxygen, hydrogen, and helium isotopes has been documented for decades, the utility of isotopes of nitrogen, carbon, boron, silicon, sulfur, chloride, and various metals has also become widely accepted and more affordable. In this symposium, their combined application was repeatedly shown to add a new layer of understanding to hydraulic or biogeochemical studies.

The groundwater studies symposium highlighted the use of both stable and unstable (radioactive) isotopes in many typical investigations. The first day was a course designed to illustrate isotope fundamentals, dispense valuable reference material, and review several case studies demonstrating the application of isotopes for water and nitrate provenance determination and for groundwater age dating. The symposium consisted of six sessions covering various applications of isotope data, their use in forensic investigations, and their value in delineating recharge areas or as tracers.

The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership.

INSIDE

(Ed: This article has been edited for length; the complete article may be found on the GRA website, www.grac.org.)

Isotope Methods for Groundwater Investigation Course

Carol Kendall of the U.S. Geological Survey and **Jean Moran** of Lawrence Livermore National Laboratory worked tirelessly to prepare an original curriculum for this one-day course. Carol presented six chapters of information including references, general isotope fundamentals, water isotope fundamentals, isotope hydrology, isotope biogeochemistry, and ecological applications of stable isotopes. Jean followed with an introduction to groundwater age dating, which focused on

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President's Message

BY THOMAS K.G. MOHR

Groundwater — The Next Generation

The survival of GRA members' various professions in the field of groundwater depends on a good succession plan; our businesses and government agencies depend on a new crop of groundwater scientists emerging from our university system and training into our jobs to replace us as we retire from the groundwater profession. Finding entry level and skilled hydrogeologists and engineers trained in groundwater has become increasingly difficult. GRA Branch meetings typically include far more job announcements than job seekers. Recently, I heard that some Bay Area firms are resorting to issuing H1-B visas to hire hydrogeologists. From this anecdotal evidence, it seems we're facing a significant shortage of groundwater professionals. Should we be concerned?

Most universities train geologists, engineers, chemists, and toxicologists, but only at the graduate level are degrees conferred in hydrogeology and environmental engineering with a specific focus on groundwater. We first need an undergraduate pool of earth scientists and engineers to support graduate level programs in hydrogeology and environmental engineering. The best way to encourage university study in earth sciences is to get students at the high school level excited about earth sciences. Unfortunately, high school students' choices of science classes are constrained by the University of California (UC) system requirements for admittance to their undergraduate programs: biology, chemistry, and physics. The UC requirements do not consider the Earth science labs rigorous enough for UC entrance and are typically assigned to students who are not intending to attend a UC. Consequently, high school earth science classes have been cut from the budget in many schools, leaving students with little opportunity to get instruction in the fascinating field of earth science. This action has affected the number of college students pursuing majors in earth science and getting trained to teach earth science. This trend does not bode well for our profession nor for acquiring an informed citizenry which will be faced with difficult decisions associated with this planet's resources.

The eminent UC Davis geology professor emeritus, Eldridge Moores, celebrated for his work on plate tectonics in John McPhee's book, "Assembling California," helped form the California Alliance of Earth and Space Science Education to combat the demise of the high school earth science curriculum. Currently, the California Alliance of Earth and Space Science Education is pursuing a petition drive among professionals, teachers and parents to present to John Oakley, the Chair of the UC Academic Senate Council, which has the power to effect change to the UC system requirements. GRA's President encourages you to take ownership of the health and succession of your profession and your kids' future choices in high school education. Earth Science Petitions

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HydroVisions is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is 915 L Street, Suite 1000, Sacramento, CA 95814. Any questions or comments concerning this publication should be directed to the newsletter editor at editor@grac.org or faxed to (916) 442-0382.

ANNOUNCING...

Environmental Information Management Systems II

AUGUST 22, 2007
IRVINE, CALIFORNIA

GRA's 2005 Seminar on EIMS in San Jose, California was the first seminar of its kind at GRA, but it drew big crowds, far exceeding expectations, demonstrating a large interest in environmental data management. Subsequent to the seminar, GRA received requests from GRA members in southern California to repeat the event in that area. This will be an opportunity not only to repeat the event in southern California, but also to update the participants on the status of EIMS. If you are interested in exhibiting your firm's services or products at this event, please contact Ms. Mary Megarry at mmegarry@nossaman.com or 916-446-3626. GRA also welcomes co-sponsors for the seminar, breaks, luncheon and reception. Please go to www.grac.org for more information, and to register.

Upcoming Events

Mark your calendars for the 26th Biennial Groundwater Conference & 16th Groundwater Resources Association Annual Meeting

"California's Water Future: Expanding the Role of Groundwater"

SEPTEMBER 18 - 19, 2007
SACRAMENTO CONVENTION CENTER, SACRAMENTO, CA

Featuring topics such as:

- Preparing for Climate Change
- Salt Water Intrusion
- Desalination as a Tool for Basin Management
- Groundwater Resources and Land Use Planning
- Data Management
- Water Resources Infrastructure
- Delta Issues
- Groundwater Recharge and Water Quality
- Assessing California's Groundwater Quality

Initial Call for Posters: The Conference Planning Committee invites you to submit abstracts for Poster Presentations. Abstract subject areas are listed above. Abstracts are limited to a maximum of one page and should include a title, author's name and affiliation, contact information and subject area. Additional information on abstract and presentation policy and formatting requirements are available at http://www.waterresources.ucr.edu. Submit abstract and submittal form by email to: Julie Drouyor, UC Center for Water Resources at cwres@ucr.edu.

More details will be available on the UC Center for Water Resources website, www.waterresources.ucr.edu, as they develop. If you are interested in exhibiting your organization's services or products, or being an event sponsor, please contact Mary Megarry at mmegarry@nossaman.com or 916-446-3626. GRA welcomes co-sponsors, lunch, refreshment and reception sponsors.

Save the Date

Back by Popular Demand:

DNAPL Symposium II: DNAPL Source Zone Characterization and Removal

Long Beach, CA • November 14-15, 2007

Planned Symposium topics include:

- Source zone characterization and monitoring using high-resolution techniques
- Predicting source zone architecture and persistence
- Characterization and remediation strategies for deep aquifer systems
- Characterization and remediation challenges for non-chlorinated DNAPLs
- Mass flux determination/implications for source zone removal
- DNAPL site closure strategies

Wells and Words

Technical Corner

BY DAVID W. ABBOTT, P.G., C.HG.
TODD ENGINEERS

Some simple and helpful observations on basic inorganic groundwater chemistry

Review of hundreds of inorganic groundwater quality analyses reported by many different laboratories reveals certain easily observable and important relationships among the various analytes and physical properties. To assist in these observations, rather than simply list the analytes and physical properties in alphabetical order, it is more useful and revealing to list the results by meaningful and associated groups. One such tabulation is shown on Table 1, which lists the measured constituents in four California wells by the five categories: major cations, major anions, minor ions, physical properties, and trace ions. The following observations can be made:

1. Major cations and anions in groundwater are detected in concentrations typically ranging from 1 to 1,000 milligrams per liter (mg/L). The major cations include calcium, magnesium, sodium, and potassium; the major anions include bicarbonate, chloride, and sulfate.

2. The ionic balance or reaction error (RE) between the major cations and anions should be less than 5%. Aqueous solutions typically are ionically balanced. The RE is defined as the difference between the total cations and total anions divided by the sum of the ions in milli-equivalents per liter (meq/L). If the RE is greater than 5% then the analytical analysis for the individual ions may be in error or an important constituent of the solution may not have been included in the RE calculation.

TABLE 1		W-1	W-2	W-3	W-4
MAJOR CATIONS mg/L					
Calcium	Ca	51	16	10	39
Magnesium	Mg	44	7	2	22
Sodium	Na	140	92	80	484
Potassium	K	4	5	2	4
Sum of Cations meq/L		12.363	5.504	4.195	24.912
MAJOR ANIONS mg/L					
Bicarbonate	HCO_3	230	190	160	322
Chloride	Cl	79	65	17	620
Sulfate	SO_4	210	13	35	<1
Sum of Anions meq/L		10.371	5.169	3.831	22.789
MINOR IONS mg/L					
Iron	Fe	0.120	0.310	0.710	0.948
Manganese	Mn	0.003	0.180	0.025	0.172
Fluoride	F	0.20	0.27	8.00	0.10
Boron	B	<0.5	<0.05	<0.05	8.22
Nitrate as NO_3		<2	<2	11	1
Nitrite as nitrogen		<0.4	<0.4	<0.06	<0.02
Carbonate	CO_3	<1	<1	<2	13
PHYSICAL PROPERTIES mg/L					
Total Hardness as $CaCO_3$		310	68	36	188
Total Alkalinity as $CaCO_3$		230	160	130	335
Total Dissolved Solids	TDS	690	340	270	1,410
Electrical Conductivity µmhos/cm	EC	1,100	550	430	2,600
pH Units		8.1	7.6	7.9	8.4
Apparent Color		<2	6	<2	>70
Odor Units		<1	2	<1	<1
Turbidity NTU		0.21	0.88	9.10	12.70
TRACE IONS mg/L					
aluminum	Al	<0.05	<0.05	0.67	0.614
antimony	Sb	<0.006	<0.006	<0.002	<0.002
arsenic	As	0.0028	<0.002	0.0038	0.0110
barium	Ba	<0.1	0.100	0.041	0.339
beryllium	Be	<0.001	<0.001	<0.001	<0.001
cadmium	Cd	<0.001	<0.001	<0.0005	<0.001
chromium	Cr	<0.01	<0.01	0.012	<0.01
copper	Cu	<0.05	<0.05	0.0074	<0.05
lead	Pb	<0.0002	<0.005	0.0013	<0.005
mercury	Hg	<0.001	<0.001	<0.001	<0.001
nickel	Ni	<0.01	<0.01	<0.002	<0.01
selenium	Se	0.0046	<0.005	<0.005	<0.005
silver	Ag	<0.01	<0.01	<0.01	<0.01
thallium	Tl	<0.001	<0.001	<0.001	<0.001
zinc	Zn	<0.05	<0.05	<0.01	0.082

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Technical Corner

Tritium Age Dating of Groundwater

BY WILLIAM E. MOTZER, PH.D., P.G., TODD ENGINEERS

Numerous methods exist for age dating groundwater, including carbon-14, krypton-85, chlorine-36, and chlorofluorocarbon analyses. Many of these methods require either large quantities of sampled water, have complex chemical analysis, or require instrumentation found in only a few laboratories. However, the simplest, most frequently used, and currently most popular method involves analyzing water for isotopes of hydrogen and helium; this technique is discussed below.

Tritium Fundamentals

Tritium (T) or ^{3}H is a radioactive isotope of hydrogen (having two neutrons and one proton) with a half-life of 12.4 years. Tritium concentrations are measured in tritium units (TU) where 1 TU is defined as the presence of one tritium in 10^{18} atoms of hydrogen (H).

In the earth, small amounts of natural tritium are produced by alpha decay of lithium-7. Natural atmospheric tritium is also generated by secondary neutron cosmic ray bombardment of nitrogen, which then decays to carbon-12 and tritium. Tritium atoms then combine with oxygen, forming water that subsequently falls as precipitation.

Prior to atmospheric nuclear weapons testing in the 1950s, tritium's natural average concentrations ranged from approximately 2 to 8 TU. Approximately 1.13×10^{9} TU were added in the northern hemisphere from atmospheric nuclear testing, with the largest tritium concentrations peaking in 1963; since cessation of the tests, concentrations have dropped to between 12 and 15 TU. Because most tritium enters the environment as precipitation, it eventually becomes concentrated in levels detectable in groundwater.

Tritium Method

Because groundwater tritium concentrations reflect atmospheric tritium levels when the water was last in contact with the atmosphere, tritium can be used to date groundwater recharge. Given that TU values vary both spatially and temporally, it is important to establish the closest precipitation measurement point to provide a reference to estimate groundwater recharge and travel times. Groundwater age estimation using tritium only provides semi-quantitative, "ball park" values:

- <0.8 TU indicates submodern water (prior to 1950s)
- 0.8 to 4 TU indicates a mix of submodern and modern water
- 5 to 15 TU indicates modern water (<5 to 10 years)
- 15 to 30 TU indicates some nuclear testing tritium
- >30 TU: recharge occurred in the 1960s to 1970s

In the period of three half-lives (1963 to 2000), tritium concentrations have been reduced by a factor of 8. With no further atmospheric nuclear testing, tritium will continue to drop to near natural background levels. Therefore, the utility of tritium for age dating recent groundwater recharge is approaching an expiration date.

Tritium-Helium-3 (^{3}He) Method

Tritium decays to 3He by beta particle emission, and knowing this decay rate allows for a more accurate shallow groundwater recharge age. T/^{3}He ratios are useful for groundwater ages ranging from several months to about 30 years, and have an accuracy of one to three years. Groundwater ages can be estimated using the following equation:

$$\text{Groundwater Age (in years)} = -17.8 ln\ (1 + {}^{3}He_{trit}/{}^{3}H)$$

where:

- $^{3}He_{trit}$ = component of ^{3}He from the decay of tritium corrected for other ^{3}He sources such as the Earth's atmosphere, small contributions from spontaneous fission of lithium-6, and from uranium and thorium decay
- ^{3}H = tritium concentration in TU

Because ^{3}He is also present within the mantle, ratios of $^{3}He/^{4}He$ in excess of atmospheric concentrations are indicative of a contribution of ^{3}He from the mantle. This commonly occurs in geothermal areas and crystalline crustal sources dominated by ^{4}He, which is produced by the decay of radioactive elements in the crust and mantle. Therefore, in other than alluvial terrain, terrigenic produced helium may give anomalous results.

Analysis

Tritium is typically measured by a liquid scintillation counter. Tritium and ^{3}He can be measured by mass spectrometry, but dissolved gases such as H_2O, CO_2, O_2, and N_2 must be first removed, generally by exposure to heated titanium.

Sampling and Cost

For tritium alone, water samples can be collected in plastic bottles. However, for T/^{3}He samples, water must be collected in crimped ("cold welded") copper tubes because helium will diffuse through glass and plastic containers. Sample costs vary from about $300 per sample for tritium alone to $1,000 per sample for T/$^{3}He$, depending on the laboratory.

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Sacramento Update

California Legislative Corner

BY CHRIS FRAHM,
HATCH & PARENT AND
TIM PARKER,
SCHLUMBERGER WATER
SERVICES

This year, the issue of groundwater and underground storage is in the forefront of water discussions in the Capitol as never before. When the Governor announced that he had asked Senator Dave Cogdill to introduce the Administration's water bond proposal in his State of the State address in January, we knew that it would be a big year for GRA. With two controversial surface water reservoirs in the Governor's proposal, many Legislators and other stakeholders are asking how much groundwater storage is available and how much it would cost to use it.

Senate Bill 59 by Senator Dave Cogdill failed passage in the Senate Natural Resources and Water Committee on a party line vote. SB 59 contains funding for two surface storage projects, the Temperance Flat and Sites reservoirs. The Democratic majority in the Senate is very uncomfortable with the environmental ramifications of surface storage. On the other hand, there is little disagreement in the Legislature that new storage is necessary in order to meet the growing population forecasted for California.

The 2007 California Groundwater Coalition (CGC) – of which GRA is a founding member – was asked by the Senate Natural Resources and Water Committee to provide groundwater storage data and cost figures to inform the Committee as it continues to deliberate the water bond proposal. A copy of CGC's response, titled "The Increasing Importance of Groundwater for California Water Supply," may be viewed on the GRA web site, www.grac.org. As the Legislative Advocates for CGC and GRA, Hatch & Parent has testified in Committee in support of SB 59 with the caveat that more funding for groundwater is necessary.

Although SB 59 stalled in Committee, the Governor and his proposal are not going away. Later this month, the "Big 5" – which consists of Governor Schwarzenegger, Senator Perata, Senator Ackerman, Speaker Nunez and Assembly Member Villines as majority and minority leaders – will begin negotiations on the state budget. While the budget is technically required to be in place July 1, this deadline is frequently missed. A late budget is even more likely with contentious issues pending, such as health care reform and surface water reservoirs. The budget requires a 2/3 majority of each house for passage. This gives Republican members of the Legislature their best bargaining positon of the year. The water bond proposal is expected to be put on the table by the Republican leadership and the Governor during these negotiations. We believe that Democrats will want more funding for groundwater storage. CGC and GRA are both on record that they will support a water bond if it contains significantly more funding for groundwater than the $500 million that is currently in the bill. CGC has been and will continue to actively lobby for this outcome in the coming weeks. It has been a major goal of CGC and GRA to keep a spotlight on groundwater while other associations and interest groups attend to the wide array of other water issues that are on the table.

In addition to the Governor's water bond proposal, Senate President Pro Tem Don Perata has introduced **SB 1002** which is the implementation bill for Proposition 84 water funds. The bill currently allocates $15 million to DWR to develop a plan for re-operating the state's flood protection and water supply systems to optimize the use of existing facilities and groundwater storage capacity. The bill also allocates $200 million for grants to integrate groundwater management with water supply management and water quality management. SB 1002 is moving through the process and is currently in the Senate Appropriations Committee awaiting further action. We anticipate this bill being on the Senate Floor early in the month of June. We are continuing to work with the Committee on amendments to refine implementation of Prop 84 in a manner that is most consistent with the objectives of CGC and GRA.

A third bill that has been of continued interest to GRA is the "annual" groundwater monitoring bill. Formerly SB 820 and then SB 1640 (both Kuehl), this year it is **SB 178** by Senator Darrell Steinberg that carries the groundwater monitoring provisions in the former legislation. The bill is currently in the Senate Appropriations Committee. The Department of Finance has estimated the state cost to be $5 million annually for the first three years of the program. GRA supports the bill and is seeking amendments to SB 1002 which may allow for implementation.

CGC will be contacting AGWA and GRA members in the days ahead to participate in lobbying visits in the Capitol targeted to support the objectives described above. We hope we can count on your support during this historic period when the importance of groundwater is being acknowledged at the same time that funding is available from the bonds voters passed last November.

California Regulatory Corner

CCGO Legislative Drive – In

BY JAMES JACOBS, CCGO SECRETARY AND CHARLES NESTLE, CCGO PRESIDENT

The Eighth Annual California Council of Geoscience Organizations (CCGO) Sacramento Legislative Drive-In was held on March 15, 2007. CCGO is a nonprofit mutual benefit corporation formed in 1997 by the three California Sections of AEG, AIPG, and AAPG to advocate the use of sound geologic knowledge and practice by proposing, reviewing, and monitoring statutes, regulations, and public policy. In addition to the founding organizations, CCGO member organizations include AWG, CGEA, Central Coast Geological Society, Davenport Geological Society, GRA, and the Monterey Bay Geological Society. There are also numerous business members.

The CCGO delegates participating this year included current CCGO President, Charles Nestle (AEG, Southern California Section), Marcia Kiesse (AEG, Sacramento Section), Betsy Mathieson (AEG, San Francisco Section), and Jim Jacobs (AIPG, California Section).

Aggregate Availability

The first meeting was with David Beeby of the State Mining and Geology Board (SMGB). Mr. Beeby discussed the fact that many urban areas in California have only about a decade or so of aggregate currently permitted for mining, and permitting new gravel quarries is a 5 to 10 year process. As aggregate supplies are depleted, significant increases in the cost of cement and aggregate-related raw materials will occur as transportation costs increase (approximately double each 30 miles). These costs will not only increase the base cost of residential construction, but the projects to be funded by the voter-approved major infrastructure improvement bonds will likely see an escalation of costs that were not anticipated. The California Geological Survey (CGS) has a new Aggregate Availability map of California available for download on their web site, or available for purchase. This map shows known supplies and permitted quantities (a fraction of what is available). There are approximately four billion tons of aggregate permitted, and there is an estimated demand for 50 billion tons. Without funding to locate additional sources, and without streamlining the permitting process for known resources, California will be paying high transportation costs.

The delegation also met with Christine Robertson, an aide to Assembly member Sam Blakeslee (a geoscientist with a PhD in Geophysics), to discuss Board for Geologists and Geophysicists (BGG) status, and funding for the SMGB and CGS. The delegation provided her with a copy of the CGS' Aggregate Availability map, discussed the threat of increased costs of aggregate, and referred her to the State Geologist for more detailed information.

The CCGO delegation later met with the State Geologist, Dr. John Parrish. He showed the delegation some recently produced maps, mostly related to hazard mapping projects. He noted that although the CGS is known throughout the world for its state-of-the-art hazard mapping program, staff, facilities and projects, the state funding for information dissemination has not kept up.

Sunset Review

The CCGO delegation met with Andrew Medina (legislative aide to Assembly member Mike Eng – Assembly member of the Sunset Committee) regarding professional and business issues for geologists and the upcoming BGG Sunset Review. We met with Carroll Mortensen, chief consultant for the Assembly Committee on Environmental Safety and Toxic Materials under Assembly member Jared Huffman. As Mr. Huffman is proposing carbon sequestration (Ed: See the Federal Corner, in this issue, for more information on this topic), we discussed some potential side effects that should be evaluated. Ms. Mortensen asked us, as geologists, our opinion of the global warming debate. Although the science doesn't necessarily support the conclusion that humans are 100% responsible for global climate change, reducing potentially toxic levels of any gas in the atmosphere would be beneficial to general health of the population. We pointed out that studying ways to mitigate the potential impacts of global climate change on infrastructure, the food chain, agriculture, and population centers could be a better use of time and resources.

G.V. Ayers and Bill Gage of the Business & Professions Committee (Senator Mark Ridley-Thomas) also discussed the upcoming Sunset Review Process for the BGG. These gentlemen have been with the Sunset Review staff for years under Senators Figueroa and Thomas. Preliminary indications are that the sunset period may be extended to eight years (rather than six), and that the upcoming sunset review may be delayed or extended as well.

Language in SB68

We met briefly with Sonia Diaz, an assistant with Senator Sheila Kuehl to discuss SB 68, the Senator's proposal to clean up language governing the SMGB. Allegedly, someone in the DCA had attempted to insert language that would have allowed the DCA to appoint any licensed geologist they wanted to the position of State Geologist. Currently the SMGB recommends candidates from which the DCA must choose. Changing that process would have made the State

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Federal Legislative/Regulatory Corner

USEPA Happenings

BY JOHN UNGVARSKY, WITH MIKE GILL (BOTH USEPA REGION 9)

Arsenic in Drinking Water Fact Sheet

EPA has released a new fact sheet designed to help the public understand the long-term health risks associated with arsenic in drinking water. Water systems with arsenic problems can use this fact sheet as part of their public education efforts. To download the fact sheet, see http://www.epa.gov/safewater/arsenic/basicinformation.html.

Guidance on Pilot Geologic Sequestration Projects

Geologic sequestration is the process of injecting carbon dioxide (CO_2) from a source, such as a coal-fired electric generating power plant, through a well into the deep subsurface. EPA has finalized Underground Injection Control (UIC) Program Guidance #83, *Using the Class V Experimental Technology Well Classification for Pilot Carbon Geologic Sequestration Projects*. The guidance will assist state and EPA regional UIC programs in processing permit applications for geologic sequestration testing projects. For more information, see http://www.epa.gov/safewater/uic/wells_sequestration.html.

Los Angeles Biosolids Injection Project

EPA Region 9 recently approved a permit for injecting municipal biosolids into the ground beneath the Los Angeles' Terminal Island Treatment Plant in San Pedro, California. The permit will allow the City, over a five-year period, to drill three wells - one injection and two monitoring wells – for injecting up to 400 tons of biosolids per day. The biosolids injection system is designed to have no effect on drinking water supplies. This proposal is an alternative to the city's current practice of applying 500 tons per day of biosolids from treatment plants to agricultural fields in Kern County where the material is applied as a fertilizer for non-food crops. For more information, see http://www.epa.gov/region09/water/groundwater/uic-permits.html or call George Robin at 415-972-3532.

New In-Situ Flushing Profiles

EPA has developed a Web site to summarize timely information about selected full- and field-scale applications of in-situ flushing technologies. The site provides detailed summary information about ongoing and completed applications to treat chlorinated solvents, petroleum products, metals, explosives, and PCBs in groundwater and soil. Projects for this website are collected using information from technical journals, conference proceedings, and other published sources. As of May 2007, the Web site includes information on 23 in-situ flushing project profiles including completed and on-going applications. For more information, see: http://www.clu-in.org/products/isf/.

API Launches New Soil and Groundwater Web Site

The American Petroleum Institute (API) has reorganized its Web site to make it easer to find technical information related to subsurface fate and transport and natural attenuation of fuel constituents, site characterization and remediation. Sections of the Web site are devoted to oxygenates (including MTBE and ethanol), light non-aqueous phase liquid, and petroleum vapor intrusion. For more information, see http://www.api.org/groundwater.

John Ungvarsky is an Environmental Scientist at the U.S. Environmental Protection Agency, Region 9 Water Division's Ground Water Office and oversees source water protection efforts in CA and NV. For information on any of the above topics, please contact John at 415-972-3963 or ungvarsky.john@epa.gov. Mike Gill, ORD Hazardous Substances Technical Liaison at Region 9, also contributed to this month's column.

Chemist's Corner

Groundwater Quality in Southeast Asia

BY BART SIMMONS

I recently returned from my third trip to Southeast Asia with Habitat for Humanity, this time to help build homes in the outskirts of Phnom Penh, Cambodia. The contrasts with the California culture are everywhere, and it was interesting to get a sense of the relative groundwater quality issues in Southeast Asia.

Southeast Asia includes some of the most densely populated and most intensively cultivated land in the world. Rainfall follows a monsoon climate pattern, with very distinctive dry and rainy seasons, which have a corresponding effect on surface and groundwater. During the long dry season, water is stored in many river basins, but during the rainy season severe floods may cause tremendous damage in those same basins. The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) supports a project on Strategic Planning and Management of Water Resources, which has identified needs for water supply and quality. One priority is to improve efficiency in municipal water utilities, which often have volumes of unaccounted-for water amounting to as much as 50 percent of total water supplied in some of the largest cities. According to UNESCAP, many countries in the area have inadequate data on water resources, especially on groundwater and water quality.

Most of the region has experienced rapid economic growth and population migration from rural to urban areas, which has created stresses on water supply and quality. The demand for water has increased the dependence on extracted groundwater. Stresses to surface and groundwater include increasing irrigation for rice production; increasing shrimp aquaculture; mining (often unregulated), resulting in contamination with arsenic from arsenopyrite, cadmium, and other toxic elements; industrial activity, particularly reclamation of metals from electronic waste and industrial waste; and the use of untreated wastewater for irrigation, leading to metal and pathogen contamination.

As an example, groundwater in Cambodia is considered to be of generally good quality, but high iron content and increasing salinity levels have been noted in Svay Rieng and southern Prey Veng Province. Many shallow wells are contaminated with fecal coliform and some areas consistently fail to meet World Health Organization water quality guidelines. Contamination of water resources has led to frequent outbreaks of cholera.

The installation of tens of millions of tube wells in the sediments of Southeast Asia has inadvertently led to the one of the most serious water-quality problems in history. An estimated 100 million people live in areas with high arsenic concentrations in groundwater. While the installation of tube wells greatly reduced gastro-intestinal diseases associated with the use of surface-water supplies, the decrease in childhood mortality provided by the groundwater has been replaced by a high incidence of arsenical disease. The detailed mechanism of arsenic release that has caused this disaster is now beginning to be understood. It is generally believed that arsenate (As(V)), initially bound to iron(III) oxide minerals in the sediments, is being released as a result of the bacterially-produced reducing environment in parts of the aquifer system. There is no consensus on why arsenic exists in these sediments, or on the source of organic carbon involved in the bacterial reduction. Arsenic contamination of groundwater is extensive in Bangladesh and Vietnam, and recent R&D has focused on low-cost methods for measurement, modeling, and removal of arsenic, particularly arsenite, from shallow groundwater.

Southeast Asia has unique water-quality issues, and one would hope that knowledge and technologies of the developed world can be applied to the severe problems.

Bart Simmons can be reached at bartonps@aol.com.

California Groundwater Association Notes

BY MIKE MORTENSSON, CGA EXECUTIVE DIRECTOR

Water Well Inspector Training

CGA worked closely with NGWA, under a contract with the US Department of Agriculture, to provide a water well inspector training session for regulatory agency personnel. The free 1-1/2-day session, including a field demonstration, was held in Sacramento on April 23-24 during the CEHA (California Environmental Health Association) Annual Education Symposium. The session was similar to past sessions conducted by CGA under contract to EPA. About 40 inspectors from state and local environmental health departments learned about geologic considerations in well siting and design, California well construction laws and standards, and other technical and practical aspects of well construction and destruction. Instructors for this session included CGA members Jeremy Wire of Geoconsultants, Ron Hedman of Hedman Drilling, Jim Loughlin of Weeks Drilling & Pump Co. and Carl Hauge, DWR (retired).

CGA plans to repeat this session at its 59th Annual Convention and Trade Show at the Silver Legacy Resort Casino and Reno Events Center on November 8-10, 2007. Other tentative seminars include Pumps and Motors (for entry level), Accounting for Profits, Well Development, Submersible Pump Failure Analysis & Troubleshooting, Water Treatment & Application, Handling Paperwork (Human Resources, Contracts, and Insurance), Well Cleaning Techniques, Geology and Well Capacity Testing, and Pump Diagnostics. See the CGA website at www.groundh2o.org for more details.

NGWA Fly-in Receives Increased Support

Requests for assistance in household water well financing, extension of tax credits for geothermal heat pumps, increased funding for LUST programs, and support of groundwater studies were the focus of the recent NGWA Fly-In in Washington, DC. Congressional reception of these requests was more supportive than in past years, noted Fly-In attendee John Hofer, CGA Legislative Chair.

Nine Californians joined over 125 other groundwater professionals from 38 states in presenting those messages to members of Congress. Attending the Fly-In were CGA members John Hofer, Dave and Darrell Landino, Jim Loughlin, Dan and Jeannie Meyer & Mike Mortensson. GRA members included Vicki Kretsinger and Tim Parker. They met with staff of Senator Diane Feinstein and Representatives Anna Eshoo, Sam Farr, Doris Matsui, Loretta Sanchez, Mike Thompson and Lynn Woolsey.

In their meetings, the California delegation asked for reauthorization plus changes to streamline the existing household water well financing program that provides minimum-cost loans to low-income persons in need of clean water. The program has been funded at a $1 million level for several years. The Foundation for Affordable Drinking Water, established by NGWA, is underway in 22 states, and currently has $1.35 million in loan funds for distribution. The need to extend and expand tax credits for geothermal heat pumps, especially in light of current focus on alternative energy sources, was supported by California Congressional members.

Established in the 1980's, the LUST (Leaking Underground Storage Tank) fund has collected one tenth of a cent per gallon of fuel sold. That equates to $211 million annual revenue plus $90 million in interest on the existing fund. The funds are used to conduct tank inspections and remediate abandoned leaking tanks. However, only $70 million has been appropriated for this important work to prevent and correct possible groundwater contamination. Support for increases was urged by our Fly-In attendees.

While all agree that management of groundwater resources is best left to local agencies, there is strong support for Federal assistance in gathering groundwater data to fill in data gaps in water and land-use planning efforts. Fly-In attendees asked for higher-level Congressional support of USGS studies that promote sound science in groundwater decisions. Further information has been compiled and forwarded to Congressional staff.

Alliance Corner

Alliance Corner

National Ground Water Awareness Week Wants You!

BY CLIFF TREYENS, NGWA

This March marked the widest distribution ever of the National Ground Water Awareness Week message of ground water protection, conservation, water well maintenance and water testing. With the 2007 event successfully completed, attention has turned to the 2008 National Ground Water Awareness Week, which will take place March 9-15, 2008. NGWA is interested in recruiting more promotional partners who are willing to carry forth the message of ground water and well stewardship to the publics they serve.

Promotional partners willing to help with National Ground Water Awareness Week are a diverse group. A sampling of 2007 promotional partners and their outreach include:

- The American Farm Bureau Federation through 50 state and 2,800 local farm bureaus.
- Ground Water Protection Council through 50 state agencies.
- Automotive Oil Change Association through oil change centers from coast to coast.
- National Environmental Health Association to 4,500 professionals.
- National Association of Conservation Districts through 3,000 districts.
- Irrigation and National Onsite Wastewater Recycling associations through thousands of members.
- The U.S. Geological Survey through its Web site.
- The National Association of Local Boards of Health through its newsletter.

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GRA FOSTERS SCIENCE COLLABORATIONS: GRA Now an Associated Society of GSA

BY VICKI KRETSINGER, GRA AFFILIATES COMMITTEE CHAIR

Since its inception, GRA has fostered opportunities for collaborating with a wide range of agencies and organizations having goals and objectives similar to those of GRA. Allied endeavors have included, but not been limited to, promoting the importance of protecting and managing groundwater resources, advancing the geosciences, and enhancing the professional growth of members. Since 1992, co-sponsors and/or cooperating organizations with GRA have included: the California Department of Water Resources, University of California – Water Resources Center, Water Education Foundation, US Geological Survey, US Environmental Protection Agency, State Water Resources Control Board, California Department of Toxic Substances Control, CalEPA, Association of California Water Agencies, California Groundwater Association, National Ground Water Association (of which GRA is an Associated State Society), International Association of Hydrogeologists, Association of Engineering Geologists, and the University of Waterloo. GRA also co-sponsors the University of California Water Resources Center Archives "California Colloquium on Water" lecture series. This series sponsors scholars of distinction who provide presentations directed toward increasing the understanding and appreciation of water resources and contributing to informed decisions about water in California.

GRA continues to encourage its alliances with other societies, organizations, and also local, state, and federal agencies in service to its members and the larger earth sciences community. As a result, in mid November 2006, GRA inquired about becoming allied with the Geological Society of America (GSA) as an Associated Society. GRA's objectives for this and its other organizational alliances include:

- Have consistent aims and goals with their alliances, particularly in regards to the advancement of the earth sciences education; and professional contributions to the understanding, protection, and management of the earth's groundwater resources;
- Explore future co-sponsored events;
- Cooperatively support legislative issues pertaining to groundwater and the groundwater industry, including actions to address national groundwater needs;
- Disseminate technical information related to groundwater;
- Offer collaborative technical/scientific input and evaluation of proposed position statements or other earth science initiatives;
- Promote and encourage geoscientists and groundwater professionals throughout the industry to contribute to the education of themselves, other members, the public, and students;
- Unite with other geoscience organizations to support and promote Earth system science education at all levels to improve our understanding

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Organizational Corner

GRA Extends Sincere Appreciation to its Chair, Sponsor and Legislative Advocates for its March 2007 *Legislative Symposium and Lobby Day*

Chair
Tim Parker,
Schlumberger Water Services

Sponsor
Metropolitan Water District of Southern California

Legislative Advocates
Chris Frahm, Hatch & Parent
Paul Bauer, Hatch & Parent

GRA Extends Sincere Appreciation to its Co-Chairs and Sponsors for its March 2007 *Isotope Methods for Groundwater Investigation* Course and *Applications of Isotope Tools to Groundwater Studies* Symposium

Co-Chairs
Jean Moran, Lawrence Livermore National Laboratory
Bill Motzer, Todd Engineers

Co-Sponsors
ARCADIS
Locus Technologies, Inc.
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RSI Drilling

Refreshment Sponsors
Daniel B. Stephens & Associates
Todd Engineers

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Malcolm Pirnie
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Sachiko Itagaki
Ted Johnson
Tom Johnson
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Christian Knoche
Taras Kruk
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Sally McCraven
Peter Mesard
Steven Michelson
Greg Middleton
Jean Moran
David Moreno
Bradford Newman
Aaron O'Brien
Kent O'Brien
William O'Brien
Frederick Ousey
Oliver Page
Mike Parkinson
Peter Quinlan
John Reay
Eric Reichard
George Reid
Roscoe Moss Manufacturing Company
Sandra Ross
David Sederquist
William Sedlak
Shaw Environmental
Thomas J. Shephard, Sr.
Schlumberger Water Services
Jordan Smith
Robert Strahan
Eddy Teasdale
David Tompkins
Kurt O. Thomsen
Susan Trager
David Tucker
City of Visalia
Ed Wallick
Gus Yates
Frank Yeamans
William Zavora

Supporter
Bruce Marvin
Tim Rumbolz

GRA Requests Nominations for the 2007 "Lifetime Achievement" and "Kevin Neese" Awards

The purpose of the GRA Awards Program is to recognize noteworthy projects and unique individual contributions related to the understanding, protection and management of groundwater. The objectives of the annual Awards Program are:

1. To provide recognition to individuals who have demonstrated leadership and continuous dedication in the field of groundwater;
2. To provide recognition for unique contributions to the field of groundwater in 2005-2006.

All nominations for the Lifetime Achievement and Kevin Neese Awards must be received by Brian Lewis at admin@grac.org no later than June 15, 2007. Nominations should be completed using the nomination forms available on the GRA's website at http://www.grac.org/awards.asp. Nominations should not exceed one page, identify the award for which the nomination is made, and include justification for the award based on the criteria listed below.

The GRA Awards will be presented to the recipients selected by the GRA's Board of Directors at GRA's 16th Annual meeting in Sacramento on September 18-19, 2007.

Awards

Lifetime Achievement: presented to individuals for their exemplary contributions to the groundwater industry, and contributions that have been in the spirit of GRA's mission and organization objectives. Individuals that receive the Lifetime Achievement Award have dedicated their lives to the groundwater industry and have been pioneers in their field of expertise.

Kevin J. Neese: recognizes significant accomplishment by a person or entity within the most recent 12-month period that fosters the understanding, development, protection or management of groundwater.

GRA Welcomes the Following New Members

FEBRUARY 15, 2007 THROUGH MAY 22, 2007

Akiyama, Wayne	Shaw Environmental
Anderson, Michael	TYBRIN Corporation
Ault, Tim	Shaw Environmental
Baden, Dan	Shaw Environmental
Baer, Douglas	Los Gatos Research
Barrientos, Henry	WZI Inc.
Bazeley, Laura	Ninyo & Moore
Beck, Stephen	Ninyo & Moore
Benelli, Andrew	City of Visalia
Bennett, Vern	Moore Twining Associates Inc.
Black, Christy	Apex Envirotech, Inc.
Bratton, Patrick	Burns & McDonnell
Carlyon, Kristen	MACTEC E&C
Castle, Bruce	Eler & Kalinowski, Inc.
Chan, Vincent	Shaw Environmental
Chau, Loi	
Colwell, Neal	ECO:LOGIC Engineering
Conrow, Jerry	Ojai Basin Groundwater Management Agency
Druhan, Jennifer	UC Berkeley
Duerig, Gilberte	Zone 7 Water Agency
Estrada, Nancy	Laboratory Data Consultants, Inc.
Farquar, Richard	Environmental Transportation Consultants
Farrier, Joel	RETEC Group Inc.
Fisher, Andrew	UC Santa Cruz
Forney, Matt	Moore Twining Associates Inc.
Fretwell, David	Moore Twining Associates Inc.
George, Michael Patrick	American States Water Company
Gill-Shaler, Jane	G.E.O.
Gordon, Kinzie	URS Group, Inc.
Gupta, Manish	Los Gatos Research
Hartwell, Trevor	Apex Envirotech Inc.
Hayhurst, Cheryl	Golder Associates
Henes, Jill	Laboratory Data Consultants, Inc.
Hoaglund, John	Geotrans Inc.
Ice, Charles	San Mateo County Environmental Health
Isaac, Jennifer	Versar, Inc.
Jeffrey, Alan	ZymaX Forensics
Johnson, Dale	TYBRIN Corporation
Kemp, Alan	Calscience Environmental Laboratories
Klein, Adam	Tetra Tech
Knoche, Christian	Brown and Caldwell
Kumamaru, Koji	San Jose State University
Kuoppamaki, Heather	Golder Associates
Lockhart, Katherine	BSK Associates
Madrid, Victor	Lawrence Livermore National Laboratory
Mallory, Bonnie	Balance Hydrologics
Mayes, Keith	Moore Twining Associates Inc.
Mayugba, Dennis	Laboratory Data Consultants, Inc.
McCarthy, Thomas	Wildermuth Environmental
McClenney, William	Environ International, Inc.
McClintock, Mark	Carmichael Water District
Mele, Thomas	TYBRIN Corporation
Milano, Deno	San Mateo County Environmental Health
Miyaki, Patrick	Hanson Bridgett Marcus Vlahos & Rudy, LLP
Moore, Carolyn	Camp Dresser & McKee
Moore, Kevin	Wildermuth Environmental
Moreno, David	Soilprobe Incorporated
Naugle, Mark	Golder Associates
Nelson, Vera	Erler & Kalinowski, Inc.
Niles, Leonard	URS Corporation
Ortega, Eduardo	URS Corporation
Oster, Jan	Precision Sampling, Inc.
Owano, Thomas	Los Gatos Research
Page, Oliver	Stetson Engineers
Parkinson, Mike	SunStar Laboratories, Inc.
Parmentier, Paul	Locus Technologies
Patterson, Christopher	Law Offices Christopher W. Patterson
Pianosi, Jim	Solinst Canada Ltd.
Pieczynski, David	URS Corporation
Quine, Richard	Pacific Geotechnology
Quinn, Tracy	Kennedy/Jenks Consultants
Radcliffe, Jeff	BESST
Ramirez, Reginald	BASELINE Environmental Consultants
Raub, Joshua	Golder Associates
Richgels, Chris	Golder Associates
Robinson, Keel	Applied Process Technology, Inc.
Ruark, Matt	UC Davis
Sanders, Christopher	Ellison, Schneider & Harris
Sawyer, Robert	Norman Dowler, LLP
Schutte, Allison	Hanson Bridgett Marcus Vlahos & Rudy, LLP
Sedlak, William	Kennedy/Jenks Consultants
Smith, Gregory	San Mateo County Environmental Health
Sorensen, Ronald	RETEC Group Inc.
Spiro, Peter	City of Visalia
Srikanth, Bak	Applied Process Technology, Inc.
Stephens, Brent	DataChem Laboratories, Inc.
Suchomel, Eric	Geosyntec Consultants
Tanner, Roland	Golden State Water Company
Van Brocklin, Dave	Hydrometrics LLC
Wilson, Mary Jane	WZI Inc.
Winey, Colleen	Zone 7 Water Agency
Zampiello, Anthony	Raymond Basin Management Board

Applications of Isotope Tools to Groundwater Studies Symposium Summary – Continued from Page 1

the tritium-helium method but touched on other age-dating isotopes, such as ^{85}Krypton and ^{14}Carbon. Together, Carol and Jean presented a detailed summary of theory and applications along with an invaluable compilation of reference materials. Carol has provided a complete set of references associated with her presentation, which can be accessed at http://wwwrcamnl.wr.usgs.gov/isoig/res/texts.html, and her presentation slides at http://wwwrcamnl.wr.usgs.gov/isoig/res/presentations.html.

Tom Mohr, GRA President and Symposium presenter Saikat Sengupta of India

Symposium Keynote Speaker: Niel Plummer, U.S. Geological Survey

Niel Plummer presented work he conducted in investigating groundwater resources in the Middle Rio Grande basin in central New Mexico. Analytical data used included isotopes (^{2}H, ^{18}O, ^{3}H, ^{14}C, ^{13}C, and ^{34}S), environmental tracers (CFCs and sulfur hexafluoride), major cations and anions, atmospheric gases, and temperature. This approach was an excellent example of how thoroughly a groundwater investigation can be conducted using multiple sources of related data. Groundwater was sampled from nearly 300 wells and springs, in addition to monthly surface water samples collected over a two-year period. Maps of these data clearly depicted influence of the active river with a depleted hydrogen isotopic signature, but also illustrated paleochannels located west of the active channel. Up to 13 hydrogeochemical zones were identified; distinctions between these zones are sharp enough to be identified in individual municipal wells serving the City of Albuquerque. Results from this investigation changed the conceptual model of the Middle Rio Grande basin by quantifying a reduced basin-wide recharge rate, clarifying that the primary source of water to the City of Albuquerque is the Rio Grande rather than the surrounding mountains, determining that historical depressed groundwater elevations reflect transient recharge rates rather than a zone of high transmissivity, and finding that groundwater ages range up to 40,000 years before present. Niel's work exemplified the use of chemical and isotopic tools that can be used to improve our understanding of the extent of non-renewable water resources, modern rates of recharge, and the associated estimate of the total volume of the renewable resource. Data collected together in this fashion are invaluable for refining hydrogeologic groundwater flow models that can be used to better manage water resources.

Examples of Isotope Uses

Sessions 1 and 2, moderated by **William Motzer** of Todd Engineers and **Michael Taraszki** of MACTEC Engineering and Consulting, consisted of seven talks discussing the use of isotopes for evaluating groundwater recharge and as tracers for groundwater flow paths. **Dr. Julie Sueker** of ARCADIS, BBL, Inc. gave the first presentation, titled *Isotope Applications for Environmental Forensic Investigations*. Dr. Sueker's first study involved the use of δ^{13}C of petroleum hydrocarbons in evaluating the source of hydrocarbon sheen in river water at a bulk oil terminal. The next case study was of a gasoline release and the associated plume of benzene and 1,2-DCA for which an *in-situ* bioremediation pilot program had been initiated. Delta ^{13}C values of benzene and 1,2-DCA indicated reasonable microbial growth rates were occurring. The third case study involved the δ^{13}C analysis of TCE, DCE, VC, and ethane to evaluate and confirm microbial degradation.

A presentation on the *Use of Stable Isotopes as a Forensic Tool to Determine Sources of Perchlorate in Groundwater in the Chino Basin* was given by Dr. Neil Sturchio of the University of Illinois – Chicago. Dr. Sturchio's research focused on δ^{37}Cl and δ^{18}O of perchlorate (ClO_4^-) as source signatures. The data collected and analyzed from groundwater in the Chino Basin pointed toward a source that had the same signature as natural perchlorate from the Chilean Atacama Desert, which comes from nitrate fertilizers once used on citrus crops in the Chino Basin. **Matthew K. Landon** of the USGS presented *Use of Multiple Isotopic Tracers to Constrain Understanding of Processes Affecting Ground-Water Quality of a Sub-Regional*

Continued on page 16

Scale, Central-Eastside San Joaquin Valley. This study was done in conjunction with the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) program and involved groundwater samples collected from 78 wells in the Merced, Turlock, and Modesto basins. Results from $\delta^{18}O$ and δD showed that there were variations in water recharge sources with mixing of high elevation and local source waters. Delta^{18}O and $\delta^{15}N$ of nitrate showed nitrate attenuation by denitrification in the western part of the study area.

Michael Singleton, of Lawrence Livermore National Laboratory, continued demonstrating examples of isotope use with *Isotopic Tracers of Human Wastewater in Groundwater Systems*. This study was conducted in conjunction with the GAMA program and evaluated analytical results from groundwater samples impacted by septic tanks in Chico and Livermore, California. Results reflect ambiguity in formerly agricultural and urban areas due to the isotopic signature overlap of nitrate sources. However, when combined with other data, nitrate sources can be appropriately identified. Younger waters consistently illustrated higher nitrate concentrations and evidence of partial denitrification that occurs in the vadose zone near leach fields. **Megan Young** of the USGS presented *The Oxygen Isotopic Composition of Phosphate: A Tool for Tracing Nutrient Sources in Aquatic Ecosystems*, showing how isotopes can help delineate anthropogenic impacts. This presentation described a novel method for culling additional information from phosphate data, particularly because phosphorous has only one stable isotope. To obtain additional data, this method takes advantage of the fact that phosphorous is typically bound to four oxygen atoms (i.e. orthophosphate). Because oxygen has three stable isotopes, the oxygen isotope signature of phosphate ($\delta^{18}OP$) can reflect mixing of different phosphate sources or biologic cycling when phosphate-oxygen is exchanged with water-oxygen.

Speaking to a recently popular topic, **Paul Hatzinger** of Shaw Environmental, Inc. presented *Stable Isotope Fractionation in Nitrate and Perchlorate During In Situ Biodegradation in Groundwater*. This presentation discussed the advantageous use of an ongoing remediation effort to demonstrate in situ fractionation of both chlorine and oxygen in perchlorate during biodegradation. The study area has been remediated using vegetable oil substrate, and a push-pull test was conducted to inject contaminated groundwater into the study area. Groundwater samples subsequently withdrawn indicated that nitrate reduction by indigenous bacteria fractionated nitrogen and oxygen at a ratio of approximately 1.2:1 ($\delta^{15}N/\delta^{18}O$), consistent with heterotrophic denitrification. The fractionation ratio for chlorine and oxygen isotopes in perchlorate was indistinguishable from that of laboratory cultures. These results are useful for assessing natural attenuation of perchlorate and for evaluating perchlorate forensics in environments where biodegradation may be occurring. Rounding out the session, **Steve Carle** of Lawrence Livermore National Laboratory presented *A New Modeling Framework for Simula-*

tion of Apparent ^{3}H-^{3}He Groundwater Age and Mixing. Steve demonstrated his use of tritium-helium (^{3}H-^{3}He) data to calibrate regional groundwater flow simulations, particularly at a study area near a dairy farm in the San Joaquin Valley, California. A new modeling framework for simulating apparent groundwater age, including the effects of mixing by pumping and dispersion, was presented. Results of Steve's work are promising, and demonstrate the successful simulation of both spatial and temporal flow patterns based upon isotopic data.

Forensics

Sessions 3A and 4A, moderated by **Michael Singleton** of Lawrence Livermore National Laboratory and **Stephanie Moore** of Daniel B. Stephens & Associates, Inc., consisted of seven talks discussing the use of isotopes as tools for conducting forensic investigations related to natural and anthropogenic constituents.

Dimitri Vlassapolous of S.S. Papadopulos & Associates presented *Source Identification and Allocation of Chlorinated Solvent Contamination Among Multiple Sources: Use and Limitations of Compound-Specific Isotope Analysis*. Case studies were discussed where the $\delta^{13}C$ values of TCE and PCE were used to identify source areas and detect the presence or absence of biodegradation. The VOC isotope signature was evaluated in conjunction with $\delta^{18}O$ signatures of groundwater to establish recharge patterns and corroborate groundwater flow model results. The use of multiple lines of evidence was instrumental in settling ongoing litigation. In another demonstration of forensic identification of VOCs, **Alan Jeffrey** of Zymax Forensics presented *Use of Carbon Isotope Ratios to Distinguish Perchloroethylene Plumes in Soil and Groundwater*. The first of two case studies included multiple onsite dry cleaning facilities that, according to similar $\delta^{13}C$PCE isotope ratios in soil and groundwater, apparently used PCE from the same manufacturer, making source allocation difficult. Compound-specific $\delta^{13}C$ values from a second site with both onsite and offsite dry cleaning facilities, however, clearly distinguished an offsite source of the PCE plume with mixing occurring onsite. **Stephanie Moore** of Daniel B. Stephens & Associates presented *Geochemical and Isotopic Tracers to Define Salinity Sources in the Lower Rio Grande Valley, New Mexico*. Multiple isotopic signatures were used to identify salinity sources; of particular concern was whether the sources were anthropogenic or natural. Isotopic results augmented chemical data and confirmed the hypothesis that the dominant salinity contributions originated from deep groundwater inflow to the Rio Grande. Importantly, results indicated that it is not possible to reproduce observed salinization by evapotranspiration and agricultural processes alone.

In another example of using isotopes to forensically identify recharge sources, **Saikat Sengupta** from the Indian Institute of Technology presented *The Role of Surface Water-Groundwater Interaction in Releasing Arsenic from Shallow Aquifer of Southern West Bengal: An Isotope Geochemical Approach*. The threat of arsenic contamination to groundwater used to supply drinking water in the Bengal Delta is significant, but stable isotope compositions of oxygen and hydrogen in water have been successfully applied to determine its source. Results confirm the long-held belief that infiltration from ponds has mobilized arsenic naturally occurring in soils. **Patrick Longmire** of Los Alamos National Laboratory presented *Application of Nitrogen Isotopes in Distinguishing Different Sources of Nitrate in Groundwater at Los Alamos National Laboratory, New Mexico*. The longtime use of neutralized nitric acid (negative variable $\delta^{15}N$ $-NO_3$ ratios) and a nearby source of nitrate from sewage effluent (positive variable $\delta^{15}N$ $-NO_3$ ratios) provided a unique opportunity to monitor subsurface nitrate transport downgradient of the source. Also discussing the impact of nitrate, **Chris Reuhl** of the University of California, Santa Cruz presented *Nitrate Dynamics Within the Pajaro River, A Nutrient-Rich Losing Stream*. Concentrations of nitrate in the Pajaro River are consistently higher during the dry season of the year and, although most solutes behave conservatively through the

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study area, nitrate concentrations are observed to decline by up to 30 percent during the rainy season. Stable isotopes of nitrate and other data suggest that denitrification is the most significant nitrate sink along the lower portion of the reach.

Ted Koelsch of K2 Enviro, Inc., presented *The Use of Tritium in Understanding the Migration Pathways and Fate of Organic Contaminants in Heterogeneous Hydrological Flow Environments*. Throughout the Midwest, carbon tetrachloride was a commonly used fumigant associated with grain silos. In two case studies, tritium isotopes were used to concisely characterize the hydrogeologic continuity of sites and to refine conceptual models of groundwater and contaminant transport.

Recharge and Tracers

Sessions 3B and 4B, moderated by **Julie Sueker** of ARCADIS BBL and **Alan Jeffrey** of Zymax Forensics, consisted of eight talks discussing the use of isotopes for evaluating groundwater recharge and as tracers for groundwater flow paths.

Arun Wahi of Daniel B. Stevens & Associates presented *Geochemical Quantification of Semiarid Mountain Recharge*, showing results of a study where geochemical and isotopic tracers were employed to discern dominant mechanisms of natural recharge to an aquifer in Arizona. Stable isotopes of the water molecule indicated that mountain recharge is the dominant recharge mechanism and that approximately 65% of the recharge is derived from wintertime precipitation. **Dr. C. John Suen** of California State University, Fresno, presented *Applications of Stable Isotopes as Tracers in Groundwater Studies – Some Examples from the San Joaquin Valley*. Three examples of stable isotope applications in the southern San Joaquin Valley show that the groundwater chemistry is primarily a product of mixing between Sierran water and various components of irrigation and waste waters, and that agricultural and industrial activities have adversely impacted regional groundwater quality.

Michael Taraszki of MACTEC Engineering and Consulting, Inc. presented the *Use of Stable Oxygen Isotopes to Delineate Recharge from CVP-Source Percolation Ponds in Llagas Subbasin, Santa Clara County, California*. The isotopic composition of CVP source water, distinct from locally-derived recharge water, was used to illustrate the lateral and vertical migration patterns of groundwater derived from the percolation pond 'source' areas. In a another example of the international use of isotope data, **Sangram Shrestha** of the University of Yamanashi, Kofu City, Japan presented *Stable Isotopes as Indicators of Groundwater Recharge System in Kathmandu Valley, Nepal: A Preliminary Study*. In Kathmandu, groundwater abstraction rates are currently greater than recharge rates and this study and future related studies are designed to apply isotopic tracers to define recharge mechanisms for the valley aquifer. **Joe Iovenitti** of Weiss Associates presented *Groundwater Relationships Between the Fall River Springs and Medicine Lake Volcano-Evaluation of All Available Data*, where hydrogen and oxygen isotope ratios were used to investigate the source of waters in Medicine Lake Highlands in Northern California. **Matthew Waterman** of Bechtel Corporation showed how hydrogen and oxygen isotope ratios could be used to investigate the source of water infiltrating a large tunnel in Riverside County, Southern California, in his presentation *Application of Environmental Isotopes in Understanding Recharge in Semi-Arid Areas*. Stable isotope ratios of the infiltrating water indicated a local source that was altered by evaporation in the unsaturated zone. The isotope ratios also allowed the recharge rate of the inflow water to be estimated.

Victor Madrid of Lawrence Livermore National Laboratory presented *A Stable Isotope Tracer Experiment Using Hetch Hetchy Reservoir Water*, and showed how the hydrogen and oxygen isotope ratios from this legendary reservoir could be used as a tracer in a remediation study. **Jordan Clark** of the University of California, Santa Barbara discussed the use of tracers, including the noble gas isotopes ^{3}He, ^{124}Xe, and ^{136}Xe, in managed aquifer recharge (MAR) studies in his presentation *Successes and Failures of Gas Tracers Experiments Near Spreading Ponds*. Trapped air beneath spreading basins can retard the tracers, complicating the calculation of the aquifer recharge rates. The use of sulfur hexafluoride (SF_6) was specifically illustrated as a useful tracer for large volumes of groundwater due to its affordable analysis and low background concentrations.

Posters

Seven technical posters were also presented at the symposium including four student posters that were evaluated and awarded prizes by GRA. All of the student posters presented high quality research in an exemplary manner. **Jenny Druhan**, from University of California, Berkeley, received first prize for

her research titled *"Use of Sulfur Isotopes to Identify Bacterial Sulfate Reduction Processes during In Situ Stimulated Bioremediation of a Uranium Contaminated Aquifer."* **Rachel Andrus**, from California State University, Los Angeles, was awarded second prize for her poster presenting her Master's research titled *"Selenium Isotopes: A Viable Tracer for Geologic Processes?"* **Glenn Shaw**, of University of California Merced, presented his doctoral research titled *"Determination of Groundwater Contribution to the Merced River during Snowmelt Using $^{36}Cl/Cl$, ^{222}Rn, and $^{3}He/^{4}He$, Yosemite National Park"* and was awarded third place. **Nelson Bernal**, from California State University, Fresno, received fourth place for a poster displaying his Master's research titled *"Application of Stable Isotopic Data to Characterize the Water Flow Through a Fractured Terrain of the Sierra Nevada Foothills."*

Special Thanks

Special thanks belong to sponsors of this groundwater studies symposium, including major sponsors **ARCADIS**, **Locus Technologies, Inc.**, **RSI Drilling and Microseeps, Inc.**, meal sponsors **Daniel B. Stephens and Associates, Inc.** and **Todd Engineers**, and the symposium organizing committee (see cover photo).

Michael Taraszki is with MACTEC Engineering and Consulting, Inc.; Julie Sueker is with ARCADIS BBL; Michael Singleton and Jean Moran are with Lawrence Livermore National Laboratory; Bill Motzer is with Todd Engineers.

can be downloaded from the California Science Teacher Association's website at the following link: http://www.cascience.org/earthscibackground.pdf, and click on Earth Science Petition. If you have questions, direct them to GRA Director Susan Garcia (ssgarcia55@verizon.net). Collecting the five signatures per petition and mailing it directly to UC takes little effort and will make an important difference.

Last year, the GRA Board of Directors decided to narrow its focus in the wide arena of education initiatives and focus primarily upon building a stronger bridge between GRA and university groundwater programs. GRA Director Jean Moran, a scientist at Lawrence Livermore National Labs (LLNL) and more importantly a parent, is leading GRA's Education Committee. The Committee is pursuing initiatives to bring more college students to GRA Branch dinner meetings and symposia, to bring experienced GRA members into university classrooms and lecture halls to promote the groundwater profession and participation in GRA, and to generate funds to support more scholarships. If you have a project with academic elements amenable to presentation at a university, and you'd like to take the time to share your enthusiasm for the groundwater profession and GRA with students, please send an abstract of your lecture and a note describing where you wish to present to Jean Moran (moran10@llnl.gov).

GRA has begun hosting student poster competitions at its symposia. At the recent Isotope Symposium, four prizes were awarded to student posters, generously sponsored by GRA's corporate members, and at last year's Emerging Contaminants symposium, three prizes were awarded. The Sacramento and San Francisco branches, two of GRA's largest branches, have both sponsored scholarship awards in recent years. GRA wishes to expand its solicitation and awards of scholarship funds to promising students of the groundwater sciences. GRA's Board will consider whether it makes sense to incorporate a 501.c.3 GRA Foundation for tax-free contributions toward scholarships. Keep GRA and the next generation of groundwater scholars in mind when it comes time to shave your pesky 2007 tax burden! GRA recently received a generous $2,000 pledge for a scholarship in the southern California area from Steve Zigan, CEO of Environmental Resolutions, Inc. and long-time GRA member. If you'd like to participate in funding or developing GRA's scholarship program, please contact Jean Moran.

GRA gives you many opportunities to share your good will with the next generation of groundwater scientists, through petitioning for the survival of high school earth science classes, by making scholarship donations, by presenting a lecture at your alma mater or hometown university, or by contributing funds for student attendance at branch meetings and symposia. Your comments and suggestions for encouraging students to pursue a career in groundwater are welcome – write or call anytime: tmohr@grac.org; 408-265-2607 x2051.

Thomas Mohr is GRA's President and a hydrogeologist with the Santa Clara Valley Water District.

Wells and Words – Continued from Page 4

3. The stoichiometric or chemical equilibrium equation between bicarbonate and carbonate is HCO_3^- = CO_{32}^- + H+ . Bicarbonate and carbonate may both be detected in the same groundwater sample at specific temperatures, pressures, and hydrogen ion concentrations (pH). Bicarbonate and carbonate may coexist in groundwater at alkaline pH concentrations. This situation may be caused in the vicinity of wells by contamination and leaching from high-pH materials, including cement surface seals, cement backfill, and some types of drilling mud.
4. Minor ions (iron, manganese, fluoride, boron, nitrogen species, strontium, and carbonate) have concentrations typically ranging from 0.01 to 10 mg/L. Generally, elevated concentrations of iron (>0.3 mg/L) or manganese (>0.05 mg/L), or a combination of these concentrations > 0.3 mg/L, will cause precipitation of these constituents from the solution, staining laundry and porcelain fixtures red or gray; excess fluoride will stain teeth and reduce bone strength, while elevated boron is toxic to plants.
5. Electrical conductivity (EC or specific conductance) is measured in a variety of units, including micromhos per centimeter (µmhos/cm). It is a convenient and easily-measured surrogate for the total ionic concentration, often referred to as total dissolved solids (TDS). TDS can be estimated from EC with an accuracy of less than 100 mg/L. For most groundwater, an approximate relationship between EC and TDS is 1 µmho/cm = 0.55 to 0.75 mg/L.
6. Increased turbidity does not generally affect the concentrations of major cations, anions, and EC, but does generally result in increased detections of trace ions and their concentrations. Typically, these trace ions range from 0.0001 to 0.1 mg/L (<100 micrograms per liter). Because of the natural filtering capability of most aquifer systems, groundwater generally is not turbid. However, stressing the system during sampling, incomplete well development, and other factors can result in a turbid groundwater sample. It is advisable to include turbidity analysis for groundwater samples in order to evaluate trace ion concentrations.

David W. Abbott is with Todd Engineers in Emeryville, and may be reached at dabbott@toddengineers.com.

GRA FOSTERS SCIENCE COLLABORATIONS: GRA Now an Associated Society of GSA – Continued from Page 11

of the complexity of Earth's systems and encourage protection of its valuable resources. (See also NGWA's position statement "Declaration of The Importance of Earth Systems Science Education" at http://www.ngwa.org/ngwainwashington/earthscience.cfm. GSA's policy statement on "The Importance of Teaching Earth Science in Schools" at http://www.geosociety.org/science/govpolicy.htm) and AGI's brochure on communicating how Earth science benefits society http://www.agiweb.org/education/WhyEarthScience/Why_Earth_Science.pdf.)

On November 26, 2006, Jack Hess, GSA's Executive Director, wrote to acknowledge receipt of GRA's application and GSA's similar interest in linking organizations having the common aim of advancing geosciences. GSA's Council has since officially approved GRA as an Associated Society.

If you have an interest in participating in some capacity in any of the affiliated activities described above, including in connection with GRA's Associated State Society status with NGWA and Associated Society status with GSA, please contact Vicki Kretsinger at vkretsinger@lsce.com or Kathy Snelson, Executive Director, at executive_director@grac.org.

Vicki Kretsinger, is the Chair of the GRA Affiliates Committee, and is with Luhdorff & Scalmanini.

National Ground Water Awareness Week Wants You! – Continued from Page 11

- The National Association of County and City Health Officials through its newsletter.
- Tractor Supply Company through its in-store magazine and credit card holders' statements.

In addition to these partners, NGWA makes Awareness Week information available to more than 10,000 news media outlets nationwide.. There is much you can do as a National Ground Water Awareness Week promotional partner. You can:

- Individually promote ground water awareness in your spheres of influence
- Mobilize your members or employees to promote ground water awareness in your service area
- Post or print something on your Web site or Newsletter
- Issue a news release to your local news media
- Make a presentation to a local group
- Distribute awareness materials

"This is a great time to learn more about America's ground-water resources...Many share the responsibility for this natural resource, and now is the perfect time to learn what you can do to help," said U.S. Geological Survey Director Mark Myers in support of the 2007 National Ground Water Awareness Week.

Help make a difference. If you are interested in helping NGWA during the 2008 National Ground Water Awareness Week, contact NGWA Public Awareness Director Cliff Treyens at ctreyens@ngwa.org or 800-551-7379, ext. 554. We welcome your ideas and assistance.

Cliff Treyens is the public awareness director for the National Ground water Association, and may be reached at ctreyens@NGWA.org.

GRA Announces the Formation of the 2007 California Groundwater Coalition

The 2007 CALIFORNIA GROUNDWATER COALITION is a joint one-year initiative of the Groundwater Resources Association of California (GRA), the Association of Ground Water Agencies (AGWA), and American Ground Water Trust (AGWT). The Coalition has been formed at the urging of California state and local elected officials who believe that increased efforts are needed to educate and inform policy makers and the public about California's groundwater resources and the role groundwater plays in providing a safe and reliable water supply for California. The major focus of the Coalition is to promote a fair share of funding for statewide groundwater programs, including 2006 and 2008 water bonds.

Mission

The Coalition's mission is to 1) educate policy makers about groundwater; 2) represent groundwater interests and promote the benefits of comprehensive groundwater management and use in legislative and other policy arenas; and, 3) promote a fair share of funding for statewide groundwater programs, including 2006 and 2008 water bonds.

Principles

While groundwater issues can be highly technical and complex, the Coalition's education and outreach program is based on the following five basic principles:

1. Groundwater development, conjunctive use, and groundwater storage have the capability to provide increased water supply reliability for California in the near future.
2. Groundwater management and monitoring are essential to the successful development and protection of the state's groundwater resources for current and future generations.
3. New infrastructure is needed to obtain statewide benefit from groundwater resources utilization and replenishment.
4. Groundwater cleanup in many areas of the state is needed to eliminate contamination and ensure high quality water, and to allow for the sustainable development and use of groundwater supplies.
5. Funding is needed to ensure the effective management and use of the state's groundwater resources.

CGC's message and mission are strictly limited to the Mission and Principles described above. CGC will not lobby for any individual region or interest; instead, it will seek to inform and lobby for the benefit of groundwater resources generally.

Governance is solely through the Liaison Members and the legislative guidelines established by CGC's adopted Mission and Principles; all parties have agreed to assess the value of the 2007 CGC initiative at the end of 2007 to determine if a more permanent role should exist for CGC. At that time, further consideration will be given to governance and other long term planning issues.

CGG is intended to be a practical response to a practical and immediate need to enhance basic education and outreach efforts in the Legislature on behalf of our groundwater resources. CGC expects to work cooperatively with ACWA and other lobbying organizations that are active in the Capitol. However, unlike ACWA, CGC's sole mission and directive will be to focus on the needs of groundwater. Numerous state and local government agencies are already on board working with CGC as either sponsoring members of the advocacy program or as educational partners.

The Liaison Members and contact information are as follows: GRA – Tim Parker (916-329-9199 x224) or tparker2@slb.com; AGWA – John Rossi or Phil Rosentrater (951-789-5037) or prosentrater@wmwd.com; AGWT – Terry Foreman (805) 371-7817 x27 or tforeman@ch2m.com.

For more information on Sacramento activities, contact Chris Frahm or Paul Bauer (916-441-1232) or pbauer@hatchparent.com or cfrahm@hatchparent.com. Go to www.grac.org for the CGC's first position paper on "Increasing Importance in Groundwater for California Water Supply."

CCGO Legislative Drive – In – Continued from Page 7

Geologist essentially a political appointment. We strongly recommended that this amendment not be included in the bill, and that there would likely be significant opposition if it were. We were told that several people had informed them of this, and that this proposed amendment would not be included.

Future Appointments to BGG

Very late in the day we met with Antonette Sorrick, Governor's Appointments Secretary (Deputy Director of Board Relations) to discuss the recent and future appointments to the BGG. Antonette and Karla Diringer (Deputy Appointments Secretary) were responsible for selecting the recent appointees to the BGG and, therefore, deserve much of the credit for the 180-degree change in management and performance of the Board.

The CCGO delegation established and renewed our contacts with key legislators associated with the professional and business committees (BGG issues), as well as environmental and funding issues (CGS and SMGB issues). We listened to their concerns and in turn explained what geologists do and how our profession is relevant to key issues, including human health & safety, natural resources, environmental protection, infrastructure, and education.

Tritium Age Dating of Groundwater

– Continued from Page 5

Further Information

A more complete discussion of age dating groundwater was given by Dr. Jean Moran (with Dr. Carol Kendall) in the March 2007 GRA course: *Isotope Methods for Groundwater Investigation*. This course will be repeated at a southern California location; so, stay tuned to a future GRA web page and *HydroVison*'s announcement.

William E. Motzer is with Todd Engineers in Emeryville, and may be reached at bmotzer@toddengineers. The complete article, including extensive references, may be found at the GRA website, www.grac.org.

REMINDER!

Increasing Groundwater Storage to Meet California's Future Demand – Challenges and Solutions

June 20-21, 2007
The Westin Long Beach
Long Beach, CA

Los Angeles Area Groundwater Recharge Field Trip

June 22, 2007
Beginning at the Westin Long Beach

This Symposium will provide the opportunity to discuss many critical factors related to groundwater storage and recharge; the field trip encompasses a reclamation plant, spreading grounds, a water treatment facility, and a groundwater treatment plant.

For more information or to sign up, go to http://grac.org/gwstorage.asp at the GRA website, or contact Mary Megarry at mmegarry@nossaman.com or 916-446-3626.

Sacramento Branch Highlights

BY STEVE LOFHOLM,
BRANCH SECRETARY

January 2007 Meeting

Christopher Richgels, P.E., a Senior Engineer with Golder Associates, gave a presentation titled *Estimating Reasonably Foreseeable Releases from Municipal Solid Waste Landfills* on January 13, 2007. Mr. Richgels formerly served as the Facilities and Engineering manager for the Sacramento County Department of Waste Management and Recycling. The State of California requires municipal solid waste landfills to develop a funding mechanism to cover costs for conducting groundwater corrective action for contaminant releases. Development of realistic cost estimates for such a "reasonably foreseeable release" requires extensive analysis of potential release mechanics associated with leachate and landfill gas, the biological processes at work within a decomposing waste mass, and failure potential of environmental controls required in modern landfills. At the Kiefer Landfill, in Sacramento, California, the data collected from the existing lined module has been used to make such an assessment. Analysis of leachate chemical data indicates municipal solid waste landfills can pose significant water quality risk within the first few years of operation, but the risk declines rapidly as the cell is sealed from infiltrating rainfall and the waste mass begins anaerobic decomposition. Installation of landfill gas collection systems also reduces water quality risks as volatile organics are removed with the landfill gas.

February 2007 Meeting

Antonia Vorster, CVRWQCB, and **Brian Lewis**, DTSC, presented our **3rd annual regulatory update** in February. Ms. Vorster is a program manager of the Groundwater Cleanup Program for the Central Valley Region with responsibilities for the cleanup and remediation of both Federal facilities and private sites. Mr. Lewis is Chief of the Geological Services Unit, Department of Toxic Substances Control. His unit is responsible for providing geological support for permitting, closing, and remediating hazardous waste sites. Ms. Vorster and Mr. Lewis addressed some of the emerging issues that are priorities of both the RWQCB and DTSC.

Ms. Vorster's presentation included a discussion of the status of the Brownfield Memorandum of Understanding that was signed by the California EPA, DTSC, and the RWQCB's in 2005; Uniform Site Assessment Tools that are used by Board staff to ensure uniform review on their projects, site closure and reuse, water quality screening tools, and the GAMA (Groundwater Ambient Monitoring and Assessment) program.

Mr. Lewis detailed other emerging issues. The DTSC is revising its draft guidance document on indoor air intrusion and plans on issuing the revised document by the end of 2007. The updates to the guidance document include using CHSSLs for plume characterization, eliminating the 100-foot buffer in favor of using site-specific data, new recommendations for soil gas sampling, and using soil matrix and/or groundwater in some cases instead of soil vapor. The DTSC is evaluating requiring the use of an active or passive vapor barrier for sites where there are risks to indoor air quality. The use of membranes as vapor barriers will no longer be permitted. The DTSC is also re-evaluating groundwater regulations to bring them more in line with federal regulations, and, continuing to improve ENVIROSTAR, a database that can be used to find contaminated sites regulated by the DTSC. The database is currently available for use, but the DTSC plans on having much more comprehensive data available in six to 12 months. Finally, the DTSC is assessing emerging technologies, including nanotechnology and pharmaceutical wastes.

March 2007 Meeting

Marty Miele, the Geophysicist Group Director for Shaw Environmental, gave a presentation titled *Geophysical Techniques for Assessing Condition of Levees*. The Sacramento River Delta is the second largest river delta in the United States. The levees were built in the 1800's and were not built to today's engineering standards. Local earthen materials were used to build the levees at the time, which consists of a wide range of materials; the levees are prone to breaching, failure, and/or other catastrophic events. The State of California recognizes the need to focus on the levees to avoid future problems. The Department of Water Resources has written a set of specifications in an attempt to find some of the physical problems before they occur. The specifications focus on using surface geophysical techniques to assess the levee conditions, and were written for reconnaissance-level geophysical surveys. Shaw performed one of the first reconnaissance-level geophysical surveys to assess the levee conditions and to evaluate the effectiveness of this method for detecting subtle anomalies that can lead to levee failure. Mr. Miele presented the geophysical methods (GPR, Resistivity) and results from 15 miles of survey conducted on the Canal Ranch Levee. Numerous anomalies were encountered that were interpreted to be various conditions within the levee structure that may cause failure. Additional data could be collected to better understand the various anomalies by using more focused geophysical surveys. These data could be used for planning repairs and/or future investigations. Utilizing the reconnaissance-level and focused-level geophysical surveys can avoid the random and expensive approach of drilling numerous boreholes that supply limited information.

San Francisco Branch Highlights

BY KATRIN SCHLIEWEN, BRANCH VICE PRESIDENT AND BILL MOTZER, PRESIDENT

January 2007 Meeting

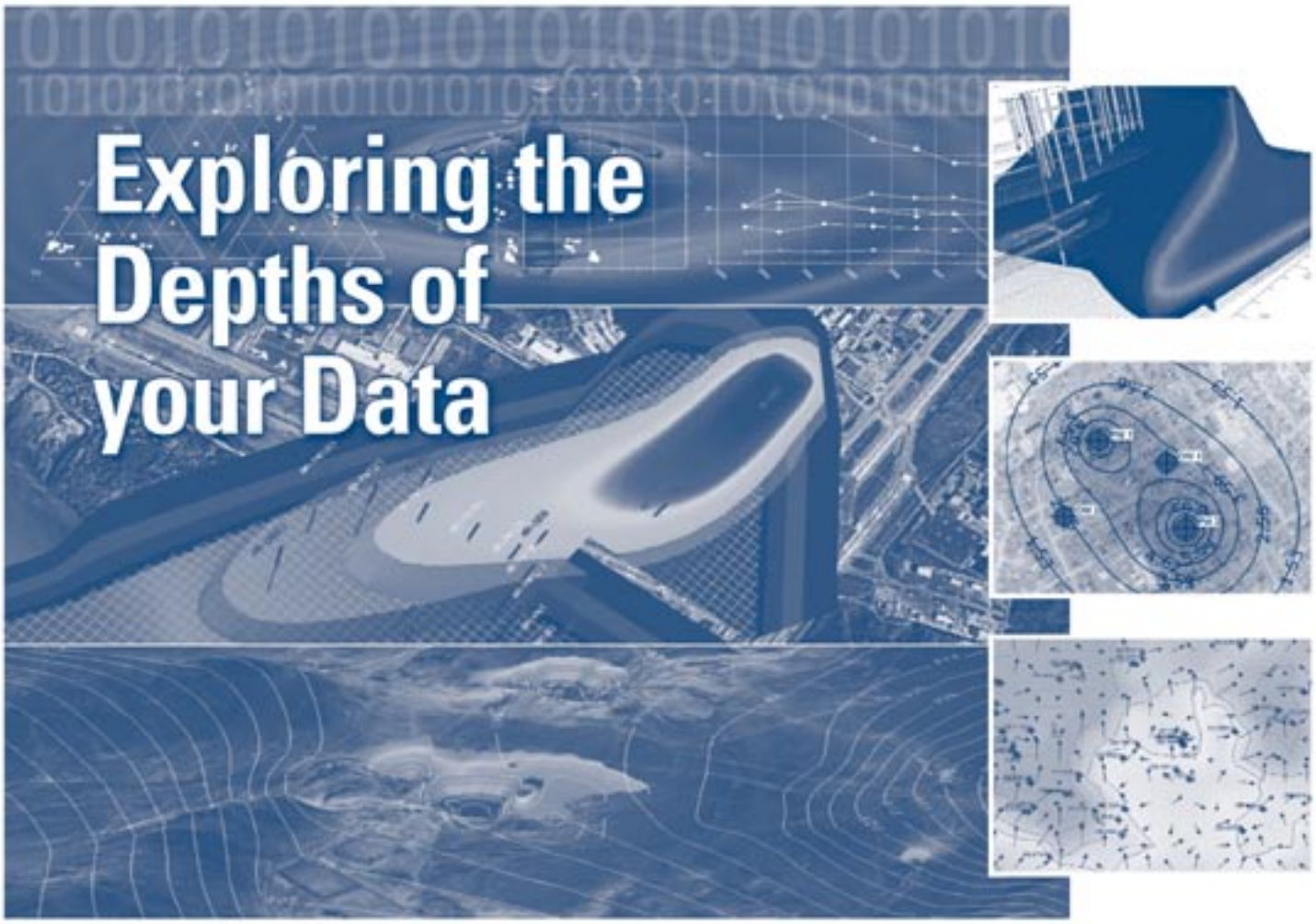
Stephen Hill, Toxics Cleanup Division Chief, and **Michael Rochette**, Groundwater Planner, provided the popular **annual regulatory groundwater update** from the San Francisco Regional Water Quality Control Board (RWQCB), which was attended by 93 members, students, and nonmembers. The presentation began with a useful review of the environmental regulatory structure in California and how the RWQCB fits in. The topics covered by Mr. Hill included: an update of the Brownfield memorandum of agreement (MOA) with details of how the RWQCB and the DTSC allocate new cases; an update about a planned partial consolidation of the three most commonly used soil screening levels (the US EPA Region IX's PRGs, the DTSC's CHHSLs, and the RWQCB's ESLs); an update after one year of increased public participation (Mr. Hill cited the positive responses to extensive public participation activities including meetings and e-newsletters coordinated to disseminate information about an ongoing TCE vapor intrusion problem at a site in Pleasant Hill); and an update of the RWQCB's efforts to further shift away from paper and toward electronic document management. Mr. Rochette gave useful overviews and updates on the continuing Basin Plan amendments and the Groundwater Ambient Monitoring and Assessment (GAMA) Program. In addition, Mr. Rochette introduced the latest projects tackled by the RWQCB's Groundwater Committee, including Low Risk Solvent Site Management and Emerging Contaminants Strategy. Mr. Hill and Mr. Rochette can be contacted via email for additional information, respectively at, shill@waterboards.ca.gov and mrochette@waterboards.ca.gov.

March 2007 Meeting

Dr. Jugdeep Aggarwal, Director of the Keck Isotope Laboratory at the University of California, Santa Cruz, gave the March dinner meeting presentation to 45 members, students, and nonmembers. This meeting was held at the Concord Hilton in conjunction with the Stable Isotope Course and Symposium. Dr. Aggarwal's talk *ISOTOPES: Old Dogs - New Tricks* focused on the development of analytical techniques and new applications of isotope research using thermal ionization mass spectrometry and multiple collector ICP-MS. He discussed the use of "non-traditional" non-radiogenic isotopes such as calcium, molybdenum, iron, chromium, strontium, and mercury. For example, calcium isotopes have been extracted from foraminifera to determine paleo temperatures; lead isotopes have been used in toxicology investigations to identify sources of lead in chocolate; chromium isotopes have been used to identify anthropogenic (i.e., plating shop) contamination from natural or geogenic sources; and, boron and strontium isotopes have pinpointed seawater intrusion sources in the Salinas Valley. Dr. Aggarwal concluded his talk by noting that this technology is still relatively young and that new contaminant isotopic tracers are being developed and that more applications are required to "ground-truth" new isotope systems.

Upcoming Meetings

The next dinner meeting will be held at Spenger's on June 20th. The speaker will be **Mr. John Karachewski** who will speak on geology, water resources, environmental issues, and California history using his excellent color slides of California landscapes.



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Dates & Details

GRA Meetings and Key Dates

(Please visit www.grac.org for detailed information, updates, and registration unless noted)

- **GRA Symposium** — *Increasing Groundwater Storage to Meet California's Future Demand-- Challenges & Solutions* — **June 20-21, 2007** Long Beach, CA
- **GRA Field Trip** — *Los Angeles Area Groundwater Recharge* — **June 22, 2007** Long Beach, CA
- **GRA Planning & Board Meeting 2007** — **August 11-12, 2007** Oakland, CA
- **GRA Conference** — *EIMS 2—Environmental Information Management Systems* — **August 22, 2007** Irvine, CA
- **GRA 16th Annual Meeting/ 26th Biennial Groundwater Conference** — **September 18-19, 2007** Sacramento, CA
- **GRA Symposium** — *DNAPL 2 – Source Zone Characterization & Removal* — **November 14-15, 2007** Long Beach, CA

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