Illinois Groundwater Association

2002 Spring Meeting

Hosted by the NIU Department of Geology and Environmental Geosciences

Held in the Illinois and Lincoln Rooms, Holmes Student Center

Northern Illinois University, DeKalb, Illinois

Wednesday, April 24, 2002

IGA

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AGENDA
Illinois Groundwater Association 2002 Spring Meeting
Northern Illinois University, DeKalb, Illinois
Wednesday, April 24, 2002

8:15 to 9:25	Registration - Coffee, Doughnuts, Muffins, and Bagels
9:25–9:30	Opening Remarks: Colin Booth, IGA Chair

Session 1

9:30-9:50	Larry Thomas (Baxter and Woodman) and Gerry Bever (DeKalb Water Superintendent) *Treatment of Radium in DeKalb's Public Water Supply*
9:50-10:10	John Jansen, Aquifer Science & Technology *In-Situ Control of Radium, the Track Record and Emerging Technologies*
10:10-10:30	Ed Smith, Illinois State Geological Survey *Glacial Geology and Groundwater Resources of DeKalb County*
10:30-10:45	***Break***

Session 2

10:45-11:05	Stephen L. Burch, Illinois State Water Survey *A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifer of Northeastern Illinois, 1995 and 2000*
11:05-11:25	Joe Domborowski, Illinois Environmental Protection Agency *TCE Plume in Downers Grove*
11:25-12:05	Robert Sanford and Charles Werth, University of Illinois *A Passive In-Situ Bioremediation Technology for Chlorinated Solvents: a Pore Scale to Benchtop Assessment*

12:05-1:20	***Lunch***

Session 3

1:20-1:40	Robert Kay, U.S. Geological Survey *Hydrogeology of the Unconsolidated and Uppermost Bedrock Deposits in the Calumet Region of Illinois and Indiana*
1:40-2:00	George Roadcap, Illinois State Water Survey *The Presence of Bacteria in Extremely Alkaline (pH>12) Groundwater at Lake Calumet*
2:00-2:10	***Break***
2:10-2:30	Philip Carpenter, Shawkat Ahmed, and Michael Nellinger (Northern Illinois University) *Geophysical Identification of Karstic Recharge Points in East-Central Illinois*
2:30-2:50	Larry Lyons, Lyons Well Drilling *NGWA Update: Brownfield Legislation, Farm Bill & Right to Own*
2:50-3:10	TBA
3:10-3:30	Business Meeting

In-situ Radium Control, the Track Record and Emerging Technologies

John Jansen, P.G., Ph.D.
Aquifer Science and Technology
W233N2080 Ridgeview Parkway, Waukesha, WI 53188-1020
JJansen@Ruekert-Mielke.com 262-542-5733

The interim standard for radium and gross alpha will take effect in December of 2003. Hundreds of water supply wells in the Cambrian-Ordovician sandstone aquifer in the upper midwest will exceed the standard of 5 pCi/l for radium 226 and 228 (combined) and 15 pCi/l for gross alpha. Most of these wells are located in Illinois, Wisconsin, Iowa, and Minnesota. Current treatment technology for radium and gross alpha includes ion exchange, lime softening, hydrous manganese oxide, and membrane softening. These methods are effective, but require significant capital and operating expenses. In addition, these methods can create waste disposal problems.

Several communities have experimented with alternative ways to comply with the radionuclide rule. These methods include finding low radium water sources from the shallow aquifers as a blending source, and reconstructing sandstone wells to reduce the radium levels. The blending well option has several advantages in that it provides additional water for the system and increases the flexibility of aquifer management options. However, it is only appropriate for systems with low radium sources of water that are available at a reasonable cost. The well reconstruction option has been successful for several communities. However, it requires extensive investigation to determine the viability of the method and is probably not practical for most wells. New geophysical logging methods that include down hole water sampling and flow measurements while pumping have significantly reduced the uncertainty in the evaluation phase.

A new experimental in-situ leaching process may be tested soon that could reduce radium and gross alpha levels at a significantly lower cost. The process involves injecting a leach solution composed on simple food grade inorganic salts, such as sodium chloride, into the formation through the well. The leach solution displaces cations sorbed onto trace levels of iron hydroxides and clay minerals present in the formation. Easily exchangeable ions, such as sodium, are left in place on the sorption sites. The leach solution is then purged to a sanitary sewer. When the wells is placed back into service, cations with higher affinity for the sorption sites displace the sodium and bind to the formation. Radium has a higher affinity for the sorption sites than most common cations such as calcium or magnesium. As a result, radium will selectively displace these cations and bind to the sorption sites. Many constituents of gross alpha are expected to also sorb onto the formation, thereby reducing gross alpha levels as well. The process is analogous to treating the aquifer as a large ion exchange filter bed. The exchange capacity of the formation is low, but is believed to be adequate to handle the parts per quadrillion levels of radium present in the ground water. Eventually, the sorption capacity of the treatment zone will be exhausted and the process will need to be repeated to reduce radionuclide levels. A field trial is expected to be completed by early summer that will determine the viability of the process.

Geology and Groundwater Resources of DeKalb County, Illinois Featuring the Troy Bedrock Valley

R. C. Vaiden, E. C. Smith, and T. H. Larson
Illinois State Geological Survey
615 E. Peabody Drive, Champaign, IL 61820
esmith@isgs.uiuc.edu 217-244-2773

Future growth in groundwater development in DeKalb County may increasingly rely on resources within the buried Troy Bedrock Valley. Although aquifers within the valley are not currently major groundwater suppliers, pressures resulting from increasing rural population and water quality issues (such as radium associated with bedrock wells) may drive the development of this resource. Compared to bedrock aquifers, the aquifers within the buried Troy Bedrock Valley are quite variable, but they are generally more productive than other drift aquifers found elsewhere in the county.

Variability within the aquifers of the Troy Bedrock Valley of DeKalb County is more easily understood by considering the three informal units comprising the sediments of the buried valley. The basal unit is found at the base of the Troy Bedrock Valley. This unit contains thick deposits of sand and gravel interpreted to be glacial outwash, interbedded with silt and clay in interpreted to be predominantly lacustrine deposits, and possibly diamictons (till). In most places, the unit is predominantly sand, but as much as half of this unit may be composed of fine-grained materials.

The middle unit of the valley deposits is dominated by thick, fine-grained, deposits. The fine grained deposits appear to be predominantly lacustrine in origin, and varved deposits have been observed in samples retrieved during water well drilling. During times that these sediments were being deposited, the stream flow was restriced creating lacustrine environments. Although coarse-grained deposits are usually a minor component of this unit, thick sand and gravel deposits are present within this interval in several locations within the county.

The upper unit is the uppermost sediment sequence in the Troy Bedrock Valley. This unit is composed almost exclusively of thick diamicton (till) belonging to the Tiskilwa Formation. Some interbedded sand and gravel is present in some areas. Surficial materials of this unit may include younger Wisconsin Episode diamicton (Lemont), as well as coarse-grained glacial deposits, and fine-grained alluvial deposits. The top of Ashmore Tongue of the Henry Formation marks the base of this unit.

The most productive aquifers within the buried valley are found where sand and gravel deposits of the lacustrine/outwash unit lie directly over and are hydrologically connected to sand and gravel deposits of the basal outwash unit. This occurs at several places in the northern part of the county. However, connections are not always obvious from conventional two-dimensional mapping techniques. Sand and gravel aquifers that appear to be separate deposits within a particular drill hole, may be hydrologically connected elsewhere.

A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifer of Northeastern Illinois, 1995 and 2000

Stephen L. Burch
Illinois State Water Survey
2204 Griffith Drive, Champaign, Illinois 61820
s-burch@uiuc.edu 217-333-5388

This report presents a potentiometric map of the Cambrian-Ordovician aquifers in a 15-county area of northeast Illinois. Groundwater levels were measured in 367 deep bedrock wells during Fall 2000 and compared to previous measurements. The potentiometric surface shows that there is a pattern of flow east and west from a small groundwater divide in northeast Illinois and southeast Wisconsin. In Illinois deviations from this pattern occur, especially in northern Cook County, near Joliet, and near DeKalb. Groundwater also flows south in LaSalle County and discharges to the Illinois River.

The groundwater levels at 298 wells were collected in both 1995 and 2000. The differences in the levels were plotted on a map and examined. It is concluded from a comparison of the 1995 and 2000 potentiometric surface maps that groundwater recovery in the smaller eight-county Chicago region has slowed. Large areas of the study area have water-level changes ranging from increases of 25 feet to decreases of 25 feet. This is in contrast with the measurements of 1985, 1991, and 1995 when observed changes generally were increases on the order of 50 or 100 feet.

This is the eleventh report by the ISWS since 1959 when it expanded its program of collecting and reporting water-level and pumpage data for deep wells in the Chicago region. The objectives of the program were: 1) to provide long-term continuous records of pumpage and water-level fluctuations, 2) to delineate problem areas, and 3) to report hydrologic information to facilitate the planning and development of water resources of the deep bedrock aquifers in the Chicago region.

Pumpage from deep bedrock wells for public and self-supplied industries in the eight-county Chicago region increased from 200,000 gallons per day (gpd) in 1864 to 175.9 million gallons per day (mgd) in 1980. Peak pumpage of 182.9 mgd occurred in 1979. Then during the period from1980 to1985, pumpage from deep wells in the eight-county Chicago region dropped from 175.9 to 157.7 mgd, a decrease of 18.2 mgd or 10.3 percent.

Pumpage continued to decline from 1985 to1991, but at a rate that was double that of the 1980 to 1985 period. A great decline in deep well pumpage occurred between 1991 and 1992 due to shifts by municipalities in DuPage and Lake Counties to Lake Michigan water; and in Kane County to the Fox River. By 1994, Cambrian-Ordovician pumpage had declined to 67.1 mgd and was concentrated in the Joliet area. Pumpage from these bedrock aquifers has steadied and risen slightly to about 72 mgd since 1995. The largest demand is made by public water supplies in Will and Kane counties, followed by industrial use in Cook and Grundy counties. The area of greatest pumpage continues to be in Will County. Correspondingly, the deepest part of the potentiometric surface occurs in northern Will County.

TCE Plume in Unincorporated Downers Grove

Joe Domborowski
Illinois Environmental Protection Agency
EPA4505.PO_BOL.DO_BOL@epa.state.il.us 217-558-2564

Background
Downers Grove is located in northeastern Illinois, in Dupage County. The Illinois EPA investigated a Downers Grove public well contamination problem during 1987 and 1988, because Downers Grove public water supply wells #6 and #8 exhibited TCE contamination. The U.S. EPA also investigated the contamination. Consequently, wells were shut down - well #8 was sealed and abandoned in 1991, and well #6 was sealed and abandoned during 1993. And, another public well in the area, known as the Belmont-Highwood, was shut down. The Illinois EPA, U.S. EPA, and their contractor were not aware of private water wells in the area of unincorporated Downers Grove. Because the Downers Grove Community Water Supply was switching from groundwater to Lake Michigan water, the U.S. EPA contractor recommended no further action. The U.S. EPA concurred with this recommendation on June 23, 1992.

Fast-forward 12 years and the Illinois EPA is conducting a groundwater investigation in Lisle, Illinois, a community located immediately adjacent to unincorporated Downers Grove. From information gathered from that investigation, on April 30, 2001, the Illinois Department of Public Health and the Illinois EPA collected fourteens samples from private wells located in the unincorporated Downers Grove area. The results indicated a potential widespread TCE and PCE contamination problem.

Consequently, the Illinois EPA immediately began an extensive investigation for potential sources of groundwater contamination in the Downers Grove area. As part of the source investigation, the Illinois EPA and U.S. EPA have extensively surveyed most businesses and industries in the area that use or may have used chlorinated solvents, and have issued a number of Information Request Letters to local businesses. A joint U.S. EPA - Illinois EPA field investigation is currently ongoing.

VOC Contamination
Since the adoption of the Illinois Groundwater Protection Act (IGPA) in 1987, the Illinois EPA has been investigating the potential for volatile organic compound (VOC) contamination in the State's groundwater. VOCs represent a family of chemicals that includes degreasing and cleaning solvents such as trichloroethylene (TCE) and tetrachloroethylene (PCE). These and other solvents were used in large quantities for many years by both commercial (e.g., dry cleaners, print shops, auto repair shops) and industrial (e.g., metal parts fabricating) businesses as well as U.S. Department of Defense sites. Until environmental laws were passed in the 1980s that required stricter waste management practices, businesses or private individuals may have paid haulers to dispose of these waste solvents or they may have dumped the waste solvents on their own property. Any time solvents are disposed of on the ground, they can move into groundwater over time as rainwater washes them from the upper soils into the groundwater.

In unincorporated Downers Grove, the Illinois EPA has collected 493 individual groundwater samples from private wells, from a potential population of 700 private, residential wells. And, 209 of the 493 samples exceed the U.S. EPA's MCL for TCE/PCE. Unfortunately, this contamination is very widespread throughout the bedrock in the area.

How Were Private Wells Overlooked?
Obviously, there was an unawareness of private wells users!

I wish to thank Rick Cobb of the Illinois EPA for the following. The Illinois EPA, by law, has authority to regulate public water supplies; that is, water supplies that serve at least 15 connections or at least 25 people for greater than 60 days. The Illinois Groundwater Protection Act required the development of well site survey reports to provide information on groundwater quality and potential sources of contamination relative to 1,200 community water supplies in Illinois; not private well users. These reports were sent to the county, the municipality, any applicable regional planning committee and the owners and operators of the Community Water Supply wells. The well site survey report for Downers Grove, including information on Wells #6 and #8, was provided to Downers Grove on April 14, 1989. Again, there was an unawareness of private wells users in the area.

The Illinois Groundwater Protection Act established the Interagency Coordinating Committee on Groundwater (ICCG). The State agencies that make up the committee are the Illinois EPA, Illinois Department of Public Health, Illinois Department of Commerce and Community Affairs, Illinois Department of Agriculture, Illinois DNR, including the Water and Geological Surveys, Office of Water Resources and Office of Mines and Minerals, the Office of the State Fire Marshal, the Illinois Department of Nuclear Safety, and Illinois Emergency Management Agency. The ICCG is currently developing procedures to coordinate the response of the state and local government bodies to specific incidents of groundwater pollution; and, how to coordinate and disseminate the information.

Personal Observations
An all inclusive, private well database does not exist. In addition to reviewing USGS and Illinois State Water Survey databases, it is necessary to pursue one or more of the following courses of action in order to identify the location of private wells.

1. Contact the local water suppliers for assistance.
2. Contact the local Health Department for assistance.
3. Physically drive by and ask residents if they have a private well.

A Passive *In-Situ* Bioremediation Technology for Chlorinated Solvents: a Pore-Scale to Benchtop Assessment

Charles Werth (werth@uiuc.edu, 217/333-3822)
Robert Sanford (rsanford@uiuc.edu, 217/244-7250)
Department of Civil and Environmental Engineering
University of Illinois at Urbana-Champaign

Improper handling, storage, and disposal of the toxic cleaning solvent tetrachloroethene (PCE) has resulted in contaminated sediments and groundwater supplies across the United States. Indigenous bacteria can often be stimulated to degrade PCE by injecting electron donors and nutrients into zones of contamination. Unfortunately, this injection process is labor and cost intensive, can result in well-clogging due to an excess of microbial growth, and often fails to maintain the proper reducing conditions necessary for reductive dechlorination. To properly implement bioremediation and successfully create conditions favorable for dechlorination, studies are required at different scales: the pore scale, the bench-scale and finally the field scale.

In order to investigate the behavior of contaminants and dechlorinating microorganisms at the pore-scale, a micromodel with a 2D pore structure etched in a silicon wafer was used. Both flow and chemistry of influent water could be controlled in the micromodel system allowing for direct observation of pollutant and microorganisms via microscopy. To specifically address how a dechlorinating bacterial population responds to a contaminant, tetrachloroethene (PCE), a micromodel with two influent ports, one for an electron donor (2 mM lactate) and one for the electron acceptor (PCE), was set-up. To evaluate how the PCE concentration affects microbial growth in the pore-matrix, the PCE loading was increased incrementally. Results showed that growth only occurred at the PCE/lactate interface and moved in the direction of the chloroethene gradient. The direction of growth reversed when the PCE concentration was doubled and showed signs of stress when the PCE reached near saturation conditions. GC analysis confirmed PCE dechlorination to dichloroethene (DCE).

At the bench-and field-scale a new, low cost, passive remediation technology called Halorespiration Enhancing Redox Transition Zone (HERTZ) was developed to accelerate the dissolution and degradation of chlorinated aliphatic hydrocarbons. It involves injecting chitin into fractures or wells located upgradient from and in the source of CAH contamination. Column studies indicate that as the chitin degrades, fatty acids and H_2 are slowly produced, creating an anaerobic, reducing environment ideal for reductive dechlorination. Fatty acids act as surfactants to increase the solubility of contaminants and, along with hydrogen, can serve as electron donors for CAH biodegradation. In addition, since chitin degrades slowly over many months, it discourages clogging and provides a long-term energy source for bioremediation that requires very little maintenance. The first test application of the HERTZ technology at the field scale was conducted at the Distler Brickyard Superfund Site near Louisville, Kentucky. A total of 450 pounds of chitin was injected as a slurry into three fractures near a suspected source of CAH contamination. The results of monthly groundwater monitoring at the site show that the VFA concentrations did increase significantly in monitoring wells near the point of injection. Associated with the release of VFAs was an indication of some dechlorination activity. Although further work is planned at all scales, results each type of study will be integrated to provide a better informational framework for promoting bioremediation.

Hydrogeology of the Unconsolidated and Uppermost Bedrock Deposits in the Calumet Region of Illinois and Indiana

Robert T. Kay, Hydrologist
U.S. Geological Survey
1420 Sycamore Road, DeKalb, Illinois 60115
rtkay@usgs.gov 815-756-9207

The Calumet area of northeastern Illinois and northwestern Indiana is one of the most heavily industrialized regions of the United States. The presence of wetlands, the proximity to Lake Michigan, the vulnerability of aquifers that supply water for much of the region and many facilities that are subject to environmental regulation and remediation, have made the hydrology of this geographic area a focal point of investigation for many conservation organizations, industries, waste-disposal concerns; and Federal, State and local government agencies.

Isotope and hydraulic data indicates that the surficial Calumet aquifer is a well-mixed hydrogeologic unit. The aquifer is recharged areally by precipitation and locally may be recharged by surface water. The residence time of ground water in the aquifer is approximately 5 to 15 years. Ground-water velocity through the Calumet aquifer is estimated to be 400 to 2,300 ft/yr. The permeable deposits, shallow water table, lack of an overlying confining unit, and proximity to numerous contaminant sources indicate that the Calumet aquifer is vulnerable to contamination.

Isotopic data indicate that ground water in the confining unit underlying the Calumet aquifer is derived from a variety of sources that include Lake Michigan, modern precipitation, and perhaps prior discharge from the basal Silurian-Devonian bedrock aquifer. The source and apparent age of the water is variable and appears to be affected locally by various geologic and hydraulic factors. The data indicated that the weathered part of the confining unit may be more vulnerable to contamination than the relatively invulnerable unweathered confining unit.

Ground water in the basal Silurian-Devonian aquifer is derived from Lake Michigan, glacial-age water and modern precipitation. Post-1953 recharge has occurred in the vicinity of Stony Island, Ill. Ground-water recharge of the Silurian-Devonian aquifer may be occurring near Calumet Harbor. The Silurian-Devonian aquifer is vulnerable to contamination where the confining unit is thin or absent, or where the integrity of the confining unit has been compromised.

The Presence of Bacteria in Extremely Alkaline (pH>12) Groundwater

George Roadcap, Hydrogeologist
Illinois State Water Survey
2204 Griffith Drive, Champaign, Illinois 61820
217-333-7951 roadcap@uiuc.edu

In the Lake Calumet region of southeast Chicago, extremely alkaline conditions (pH>12) exist in shallow groundwater and in surface waters dominated by groundwater discharge. The high pH is caused by the consumption of protons during the weathering of silicates and metallic iron in the steel slags that were used as fill. During this process metals can be released that can then be coprecipitated with the weathering products or migrate out of the system as colloids. Very little is know about which bacteria might live in this type of environment or in what geochemical reactions they could play a major role. Simple culturing tests have shown that bacteria are living in the system. Genetic sequence of 16s rRNA from bacteria at six sites with pHs over 11 show a wide diversity of PCR products. Two species, Leptothrix mobilis and an uncultured bacterium, accounted for 45 and 48 of the 340 sequencing results, respectively, and were found at multiple sites. The next most common species occurred only 8 times. Based on 489 to 599 base pairs, the PCR products from each site were all 98% similar to the Leptothrix mobilis in the database. The percentage match would indicate the analyzed bacteria may be a new strain, possibly one that has adapted to the extremely alkaline, metal-rich conditions found throughout the Lake Calumet region. The PCR results also identified many species that are present but probably not growing, including many associated with mammalian guts or infections that could have been introduced to the shallow groundwater from the surface. Leptothrix has the potential to be very important in the groundwater system because it is associated with iron and manganese oxidation. These metals are deposited as oxides in sheaths that surround a chain of cells. After the cells die the more stable sheaths could settle out or potentially migrate in the ground water as colloids. Experiments are currently underway to isolate these sheaths for analysis.

Geophysical Identification of Karst Recharge Points in East-Central Illinois

Philip J. Carpenter, Shawkat Ahmed, and Michael Nellinger
Dept. of Geology and Environmental Geosciences, 312 Davis Hall
Northern Illinois University, DeKalb, Illinois, USA
phil@geol.niu.edu 815-753-1523

Karst aquifers supply a significant fraction of the world's drinking water. These types of aquifers are also highly susceptible to pollution from the surface with recharge usually occurring through fractures and solution openings in the upper bedrock that are connected to the earth's surface by soil pipes. In these settings surface geophysical surveys, calibrated by a few soil cores, may be employed to identify these recharge openings, and qualitatively assess the protection afforded by the soil cover. In a test of this hypothesis geophysical measurements were made over different areas of the Perry Farm Park in Bourbonnais, Illinois. A 1 to 4 m thick mantle of loess and till blankets karstified Silurian dolomite at this site and the water table is generally 5 to 10 m deep, lying within the bedrock. Soil pipes above enlarged bedrock fractures exhibit high conductivity in the eastern part of the Park where 3 to 4 m of soil overlies bedrock. Soil moisture appears to be enhanced along these pipes. Soil pipes are resistive features in the western part of the Park where only 1 to 2 m soil cover is present. In both areas two-dimensional inverted resistivity profiles appear to image soil pipes as well as shallow bedrock fractures and conduits associated with these pipes. A bedrock conduit at 2.5 m depth and a paleocollapse zone were also directly identified by ground-penetrating radar (GPR) surveys in the western part of the Park. Surface geophysical surveys are thus a viable tool for characterizing these types of recharge features in karst areas with thin soil cover.

Contact Information for Other Speakers

Gerry Bever, 815-748-2050
DeKalb Water Superintendent

Larry Lyons, 815-947-3310
Lyons Well Drilling, 9795 US Highway 20 E, Stockton, IL 61085-0937