ILLINOIS GROUNDWATER ASSOCIATION

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Fall Meeting: October 27, 2017

Fermilab
IARC Lecture Hall
Kirk Rd
Batavia, IL 60510

Registration: 8:15 AM – Opening Remarks at 9 AM –Tours at 1:45 PM – Close Meeting at ~ 4 PM

Tentative Program Speakers/Topics:

9:15 AM— **Vedat Batu, Ph.D., P.E.**— "Well Hydraulics Solutions in Cartesian Coordinates Under Partially Penetrating Well Conditions"

9:45 AM— **Joseph M. Krienert, M.S. (candidate)** – "Reevaluating contaminant transport in the Henry aquifer, Gallatin County, Illinois"

10:15 AM— **Joseph Miller, M.S. (candidate)** – "Diurnal and seasonal variation in groundwater nitrate-N concentration in a saturated buffer zone"

10:45 AM—break

11:00 AM— **Madan Maharjan, Ph. D.**— "Heat as a tracer for studying groundwater-surface water interaction within a bank storage zone"

11:30 AM— **Chris Greer, Ph.D.**—"Fermilab Hydrogeology: the intersection of groundwater and subsurface accelerator systems"

12:00 PM— Lunch is Mediterranean --Shawarma

1:00 PM— Announcements and preparation for tours

1:30 PM—Tour shuttle buses depart from IARC building

DZero Tour 1:45–2:45 PM

MINOS Tour 1:45—2:45 PM (first group- 10 person max)

MINOS Tour ~2:45—3:45 PM (second group—10 person max)

1:45 PM— DZero or MINOS Tours or webinar*

3:45 PM —Tours complete

4:00 PM—Meeting Adjourned

*1:45 – 3:30 PM--optional Midwest Geosciences Webinar: **DESIGNING AND OPTIMIZING GROUND WATER MONITORING SYSTEMS IN SEDIMENTARY SEQUENCES: PART 3**: Case Studies Illustrating Efficiencies and Failures

Well Hydraulics Solutions in Cartesian Coordinates Under Partially Penetrating Well Conditions

Vedat Batu, Ph.D., P.E.
RAS EHS Solutions
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Abstract:

A new generalized three-dimensional analytical solution is developed for a partially-penetrating vertical rectangular parallelepiped well screen in a confined aquifer by solving the three-dimensional transient ground water flow differential equation in x–y–z Cartesian coordinates system for drawdown by taking into account the three principal hydraulic conductivities (Kx, Ky, and Kz) along the x–y–z coordinate directions. The fully penetrating screen case becomes equivalent to the single vertical fracture case of Gringarten and Ramey (1973). It is shown that the new solution and Gringarten and Ramey solution (1973) match very well. Similarly, it is shown that this new solution for a horizontally tiny fully penetrating parallelepiped rectangular parallelepiped screen case match very well with Theis (1935) solution. Moreover, it is also shown that the horizontally tiny partially-penetrating parallelepiped rectangular well screen case of this new solution match very well with Hantush (1964) solution. This new analytical solution can also cover a partially-penetrating horizontal well by representing its screen interval with vertically tiny rectangular parallelepiped. Also the solution takes into account both the vertical anisotropy (azx = Kz/Kx) as well as the horizontal anisotropy (ayx = Ky/Kx) and has potential application areas to analyze pumping test drawdown data from partially-penetrating vertical and horizontal wells by representing them as tiny rectangular parallelepiped as well as line sources. The solution has also potential application areas for a partially-penetrating parallelepiped rectangular vertical fracture. With this new solution, the horizontal anisotropy (ayx = Ky/Kx) in addition to the vertical anisotropy (azx = Kz/Kx) can also be determined using observed drawdown data. Most importantly, with this solution, to the knowledge of the author, it has been shown the first time in the literature that some well-known well hydraulics problems can also be solved in Cartesian coordinates with some additional advantages other than the conventional cylindrical coordinates method.

Bio: · He is an internationally recognized expert in the areas of groundwater mechanics including flow and contaminant transport in porous and fractured media.

· He has more than 40 years of experience as a university professor as well as practitioner in groundwater industry.

· He is the author of many publications in some internationally-recognized journals such as Ground Water, Journal of Hydrology, Journal of Hydraulic Engineering, Water Resources Research, and Soil Science Society of America Journal.

· In his publications, he presents new solutions for flow and solute as well as new concepts in the areas of flow and solute transport in aquifers.

· He is the first since the 1860s in solving well hydraulics problems in Cartesian coordinates under partially penetrating well conditions and his presentation will be in this topic.

· He is also the author of two books titled (1) Aquifer Hydraulics: A Comprehensive Guide to Hydrogeologic Data Analysis (John Wiley & Sons, Inc., New York, New York, 727 pages, 1998) and (2) Applied Flow and Solute Transport Modeling in Aquifers: Fundamental Principles and Analytical and Numerical Methods (CRC Press Taylor & Francis Group, Boca Raton, Florida, 667 pages, 2006).

· His books have been well received nationally and internationally. Apart from being used by many practicing hydrogeologists, his books are also being as text books in various universities around the world.

Reevaluating contaminant transport in the Henry aquifer, Gallatin County, Illinois

Joseph M. Krienert, M.S. (candidate)
Southern Illinois University
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jkrienert@siu.edu

Abstract:
The Henry Aquifer in Gallatin County Illinois provides groundwater for municipal, irrigation, industrial, and household wells. The greatest annual withdrawal is by a water utility that serves over 40,000 persons throughout southeast Illinois. Buried coal refuse at a mine near the water utility has contaminated the groundwater. Remediation efforts, including source control wells on the border of the mine site and low permeability caps over refuse areas, attempt to control the migration of contaminants offsite. Current mine land owners believe source control well pumping over 20 years has reduced contamination in the aquifer enough to stop pumping. However, some monitoring wells off the mine site have recently sampled high concentrations of contaminants. Previous studies failed to account for the elevated concentrations found offsite.
The purpose of this research is to reevaluate contaminant transport in this region. Specific objectives include a new conceptual model of the hydrostratigraphy and hydrology, revised contaminant source locations and loading, and new groundwater models accurately calibrated to a comprehensive set of monitoring well data. The research included extensive review of prior studies and historical records from the past 50 years. Relevant information was combined in Quantum Geographic Information System (QGIS) for the conceptual and numerical models. A new pre/post processor for MODFLOW and MT3DMS was created in QGIS to calibrate the models and simulate future conditions for risk assessment. Observed hydraulic head and sulfate concentrations from 1984-2015 were used for calibration. In addition, modeled baseflow was compared with observed streamflow in 2017. The calibrated models were used for twelve unique scenarios that forecast contamination from 2017-2068. The scenarios tested model sensitivity to changes in groundwater management and environmental conditions. The results of all scenarios show that groundwater quality immediately west of the mine deteriorates, and most scenarios suggest water utility wells near the mine are at risk. This research offers important questions for further study, valuable tools for groundwater management in the region, and shows that without active source control wells, negative impacts to water quality near the mine will likely occur.

Bio: Joseph Krienert is finishing his Master’s Thesis at Southern Illinois University.

Diurnal and seasonal variation in groundwater nitrate-N concentration in a saturated buffer zone

Joseph Miller, M.S. (candidate)
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Normal, Illinois
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Abstract:

Surface water pollution by nitrate (NO_3^-) is identified as a critical problem in agricultural land-use areas. Excess NO_3^- loading causes eutrophication and hypoxia in near-shore marine waters such as the Gulf of Mexico. Diversion of agricultural runoff into saturated buffer zones reduces NO_3^- loading. Although the mechanisms responsible for NO_3^- reduction in saturated buffer zones are well characterized, little is known about how NO_3^- concentrations vary temporally and what factors are involved. The objective of this study is to understand NO_3^- concentration variability in a saturated buffer zone on a diurnal scale within and among seasons. Sampling events occurred weekly between September 2016 and August 2017 with groundwater collected from a saturated buffer zone located in central Illinois. Water samples were withdrawn from a well screened in an unconfined aquifer at 1.5m below the surface. Seasons were defined by the 2017 solstices and equinoxes: Spring: March, 20 – June, 20; Summer: June, 21 – September, 21; Fall: September, 22 – December, 20; Winter: December, 21 – March, 19. Each collection event drew samples every hour for 24-hours; each sample was analyzed for NO_3^--N. Mean daily NO_3^--N concentration ranged from 2.18 mg/L in the fall to 4.63 mg/L in the summer and varied by a statistically significant difference for spring-fall ($t(15.90)=2.70$, $p=0.02$) and summer-fall ($t(10.91)=4.83$, $p=0.00$) combinations. The differences between maximum and minimum NO_3^--N concentration measured over 24 hours were statistically significant within spring ($t(12)=2.76$, $p=0.01$), summer ($t(8)=6.83$, $p=0.00$), fall ($t(4)=4.34$, $p=0.01$), and winter ($t(5)=3.33$, $p=0.01$). The daily timing of maximum (early- to mid-morning) and minimum NO_3^--N (mid-afternoon) concentrations showed a seasonal trend. While the magnitude of mean difference between daily maximum and minimum NO_3^--N concentration was highest in summer (0.74 mg/L) and lowest in winter (0.38 mg/L), no statistical differences were noted across the seasons. The magnitude of difference between daily maximum and minimum NO_3^--N concentration had: zero correlation with daily average air temperature, zero correlation with solar intensity, and moderate correlation with mean daily water temperature (Pearson correlation $r=0.475$, $p<.01$). The results of this study show significant diurnal variation in NO_3^--N concentration within seasons, and an observable trend in the magnitude of difference between seasons. The processes responsible for this variation likely operate both dependently and independently of the growing season.

Bio: Joe Miller is in the process of completing his Master's Thesis at ISU.

Heat as a tracer for studying groundwater-surface water interaction within a bank storage zone

Madan Maharjan, Ph. D
Visiting Assistant Professor
Northern Illinois University
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Abstract:

Temperature fluctuations in response to high-frequency intermittent pumping were observed from February 2014 to August 2016 in 14 wells within three shallow, unconfined, alluvial aquifers along the Ohio River. These temperature observations in pumping wells contained two components that alternated between pump-on and pump-off periods. Both components behaved differently in different seasons; pump-off temperatures ranged up to 3.8oC seasonally, with pump-on temperature shifts from 0.2 to 2.5oC due to produced water. Groundwater was generally warm in winter and cold in summer, but produced aquifer groundwater was of lower temperature in winter and higher in summer. The pumping-induced temperature shifts were highest in summer and winter, but in opposite directions. Groundwater lagged surface water temperature by an average of six months (range 140 to 270 days) for the majority of wells. The short-term and seasonal temperature shifts are likely spatially and temporally complex. However, the short-term shifts indicate that pumping always introduces water of different temperature to that of groundwater outside the casing at sensor elevation. This result is interpreted to indicate that stream exfiltration is a major component of the water budget to a number of these wells and the cause of the short-term shifting behavior. Water level and thermal data offer a reliable field-based method for observation of groundwater-surface water exchange in a bank storage zone.

Bio: Madan Maharjan research interests are Spatial and temporal variations in groundwater and surface water interactions, Climate and Human impact on water quality and quantity,Solute and heat transport in shallow groundwater aquifers, Groundwater modeling.

Recent Publications

Maharjan, M., and J. J. Donovan, (in preparation), Temperature variations in intermittently-pumped wells within unconfined alluvial aquifers.
Maharjan, M., and J. J. Donovan, 2016, Groundwater response to serial stream stage fluctuations in shallow unconfined alluvial aquifers along a regulated stream (West Virginia, USA): Hydrogeology Journal, p. 1-13.
Maharjan, M., and Y. Eckstein, 2013, Detecting transmissive bedrock fracture zones under cover of glacial formations using residential water-well production data: Hydrogeology Journal, v. 21, p. 1889-1900.

Fermilab Hydrogeology: The intersection of groundwater and subsurface accelerator systems

Chris Greer, Ph.D.
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Abstract:
Established in 1967 as America's national particle physics laboratory, Fermilab operates powerful particle accelerators for investigating sub-atomic particles. Today, the accelerator complex has grown to comprise seven particle accelerators and storage rings, delivering proton and other beams to detector and research experiments that involve international scientists from more than thirty countries.

The majority of the subsurface accelerator enclosures and targets (such as the DZero detector) at Fermilab are at an average depth of thirty feet below ground surface, with the exception being the NuMI tunnel that dips downward into bedrock and ends at the MINOS near-detector hall at an approximate depth of 400 feet. Multiple aquifers within these depths are regularly monitored as part of the Groundwater Management Plan at Fermilab.

The uppermost aquifer in the unconsolidated sediments (comprising the Prairie Aquigroup) frequently exhibits hydraulic connection with nearby surface water bodies including lakes, ponds and ditches with constant flow. An intermediate aquifer within the Yorkville Member till (approx. 20-40 feet below ground surface) exists in some locations at Fermilab. The depths of these relatively shallow aquifers overlap and have a potential interaction with the majority of Fermilab's subsurface accelerator structures. An additional aquifer exists at some locations at the base of the glacial sediments in either the Batestown Member till or Henry Formation sand, and is likely in direct hydraulic connection with the underlying aquifer at the top of the bedrock.

Groundwater residing in or below the Silurian dolostone bedrock aquifer, the upper surface of which is 50 to 80 feet below the ground surface in the Joliet Formation at Fermilab, as well as water in the overlying Batestown Member or Henry Formation, is classified as Class I resource groundwater. Deeper experiment structures such as the NuMI tunnel directly intersect and interact with the bedrock aquifers down to approximately 400 feet below ground surface, particularly in the Elwood Formation of the Silurian dolostone and the Brainard Formation of the Maquoketa shale group. The entire NuMI tunnel system acts as a French drain, channeling the captured groundwater to a sump in the MINOS hall where the water is pumped to the surface for use in the accelerator industrial cooling water system.

Bio: Chris Greer is a groundwater geologist in the Environmental Protection Group at Fermi National Accelerator Laboratory. He received his doctoral degree from Northern Illinois University this past December. His work at Fermilab draws on both his groundwater research in northern Illinois and his previous career as an environmental consultant.

ILLINOIS GROUNDWATER ASSOCIATION

BALLOT FOR THE ELECTION

OF 2017 OFFICERS

Chair	( )	**Amy Gahala** United States Geological Survey DeKalb, Illinois
	( )	________________________
Vice-Chair	( )	**George Roadcap** Illinois State Water Survey Champaign, Illinois
	( )	________________________
2nd Year Director	( )	**Sammy Mallow** Northern Illinois University DeKalb, Illinois
	( )	________________________
1st Year Director	( )	**Chris Greer** Fermilab Batavia, Illinois
	( )	________________________
Secretary	( )	**Dr. Eric Peterson** Illinois State University Normal, Illinois
	( )	________________________
Treasurer	( )	**Dr. Steven Bennett** Western Illinois University Macomb, Illinois
	( )	________________________
Student Representatives:		**Joe Honings** Illinois State University (Graduate Program) Normal, Illinois
		Claire Harris Illinois State University (Graduate Program) Normal, Illinois

Instructions: Place an “x” in the box opposite to the candidate of your choice. If you prefer to vote for a candidate not listed, write the name and business affiliation of the candidate of your choice in the space provided and mark with an “x”. Write-in candidates must be members of the IGA. Mail or e-mail the completed ballot to:

Eric W. Peterson, PhD
Professor
Department of Geography, Geology, and the Environment
Campus Box 4400
Illinois State University
Normal, IL 61790
(309) 438-7865

CANDIDATE FOR CHAIR: Mrs. Amy Gahala received her B.S. in Geology and Environmental Sciences from Northern Illinois University in 2009, M.S. in Geology from Northern Illinois University in 2011. She works for the U.S. Geological Survey since 2011. She is currently a hydrologist working on continuous groundwater monitoring and works at the U.S. Environmental Protection Agency through interagency agreement for reviewing Superfund Site data and reports.

CANDIDATE FOR VICE-CHAIR: George Roadcap, B.S and Ph.D. from Illinois State University, and M.S. from Ohio State University. Hydrologist with Illinois State Water Survey for 27 years, Prairie Research Institute, with research focus on water availability, groundwater quality, and groundwater modeling.

CANDIDATE FOR Second year DIRECTOR: Sammy Mallow, second year graduate student at Northern Illinois University with interests in research in water resources and arsenic contamination in groundwater in Cambodia.

CANDIDATE FOR First Year DIRECTOR: Chris Greer, Ph.D., a groundwater geologist in the Environmental Protection Group at Fermi National Accelerator Laboratory. He received his doctoral degree from Northern Illinois University this past December. His work at Fermilab draws on both his groundwater research in northern Illinois and his previous career as an environmental consultant.

CANDIDATE FOR SECRETARY: Dr. Eric Peterson is a Professor of Geology in the Department of Geography-Geology at Illinois State University. Eric also serves as the Graduate Program Coordinator for the Hydrogeology Program. Dr. Peterson earned a B.S. (1995) in Earth Science and Mathematics and a M.A. (1997) in Mathematics from the University of South Dakota, a M.S. (1998) in Geology from the University of Arkansas, and a Ph.D. (2002) in Geology from the University of Missouri. Dr. Peterson is a former Director and Chair of the IGA and currently serves as its the Webmaster.

CANDIDATE FOR TREASURER: DR. STEVE BENNETT received his B.S. (1988) in Geology from the University of Northern Iowa and both his M.S. (1990) and Ph.D. (1994) in Geology from Indiana University. Dr. Bennett joined the Western Illinois University faculty in 1994 and is an Associate Professor in the Department of Geology. He teaches courses in introductory physical geology, environmental studies, oceanography, hydrogeology, and geological field methods. Dr. Bennett is formerly a Director and Chair of the IGA and has served as its Treasurer since 2003.

Student Representatives: Joe Honings and Claire Harris have volunteered to be the student representatives to help facilitate participation and interests in the Illinois Groundwater Association.