ILLINOIS GROUNDWATER ASSOCIATION

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2015 Spring Meeting

Illinois State University – Alumni Center
Normal, Illinois 61761
April 3, 2015

Agenda and Abstracts

Illinois Groundwater Association (IGA) Spring 2015 Program Speakers and Topics
Illinois State University – Alumni Center
Normal, Illinois 61761
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7:30 – 8:00 **Registration**

8:00 – 9:30 **Webinar, Midwest Geosciences:** *"TAKING THE MYSTERY OUT OF COMPLEX GLACIAL SEQUENCES AT ENVIRONMENTAL AND GEOTECHNICAL SITES Part II: Understanding the Effects of Post-Depositional Weathering: Development of Weathering Zones and Secondary Jointing"* **presented by Tim Kemmis, PhD, PG**

9:30 – 9:45 **Break**

9:45 – 10:00 **Welcome and Opening Remarks**

10:00 – 10:30 **Kelly Warner**, US Geological Survey – "*Continuous Water Quality Monitoring of Groundwater and Surface Water"*

10:30 – 10:50 **Daniel Hadley,** Illinois State Water Survey – *"Groundwater-level Change in the Cambrian-Ordovician Sandstone Aquifers of Northern Illinois, 1980-2014"*

10:50 – 11:20 **Eric Peterson,** Illinois State University – *"Influence of Constructed Wetlands on the Local Groundwater Flow Regime of a Riparian Zone"*

11:20 – 11:45 **Alicia O'Hare**, Illinois State University – *"Determining the Effects of Physical Characteristics of Urban Storm Sewer Sheds on Water Quality in Bloomington, IL"*

11:45 – 12:00 **Awards and Recognitions**

12:00 – 1:00 **Lunch**

1:00 – 1:15 **Open Mic/Current Issues**

1:15 – 1:45 **Amy Gahala**, US Geological Survey – *"An Introduction to the USGS Groundwater Toolbox: A Graphical and Mapping Interface for Analysis of Hydrologic Data"*

1:45 – 2:15 **Samuel Panno**, Illinois State Geological Survey – *"The Use of Saline Springs and the Distribution of Chloride as Indicators of Recharge to and Groundwater Movement within the Illinois Basin"*

2:15 – 2:30 **Break**

2:30 – 3:00 **Kathryn Quesnell**, Northern Illinois University – *"Tracing Hydrocarbon Contamination through Hyperalkaline Environments in the Calumet Region of Southeastern Chicago"*

3:00 – 3:30 **Logan Seipel,** Illinois State University – *"Capture Zone Analysis of a Shallow-Aquifer Irrigation Well in McHenry County, Illinois"*

3:30 **Close Meeting**

Our Fall 2015 Meeting will be held at NIU - Naperville. Date and Event Details TBA. See you there!

Continuous Water Quality Monitoring of Groundwater and Surface Water

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The U.S. Geological Survey has been providing continuous real-time measurements of surface-water quality, including specific conductance, temperature, dissolved oxygen, pH, and turbidity, for years. New sensors have made the continuous measurement of nitrate and phosphate concentrations available and data is provided online in real time at some USGS gages. It is assumed that changes in groundwater quality occur at a much slower rate than changes in surface-water quality because groundwater moves slower. However, in some cases, the rate and amplitude of change in groundwater can be great over comparatively short time intervals. The USGS Illinois Water Science Center has been monitoring non-analyte-specific continuous water quality in groundwater over the past several years at various sites to assess this capacity for change. The application of a continuous real-time nitrate sensor in groundwater is now being explored at a shallow test well.

Groundwater-Level Change in the Cambrian-Ordovician Sandstone Aquifers of Northern Illinois, 1980-2014

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Groundwater withdrawals from the St. Peter and Ironton-Galesville sandstones in Northern Illinois have led to a decrease in potentiometric heads since pre-development. By 1980, heads in these sandstone aquifers had dropped as much as 800 feet in the Chicagoland area, resulting in a widespread cone of depression. Since 1980 many Chicago suburbs have switched to Lake Michigan water, however, urbanization in the southwest and westernmost suburbs of Chicago has led to an increase in withdrawals. To understand the impact of changing water demand, the Illinois State Water Survey (ISWS) conducted the largest synoptic measurement of water levels in the Cambrian-Ordovician sandstone aquifers of Northern Illinois since 1980. Over 600 water-level measurements were taken in 2014/2015 by ISWS staff using a combination of airline, dropline, and steel tape methods. Water level measurements were also obtained through public water supply records and recent service records from well drilling and service companies. Measurements were used to construct potentiometric surface maps and head change maps, showing the changes in water levels since 1980. Results show a recovery of heads in the Chicagoland region by as much as 200 feet due to the switch to Lake Michigan water, while drawdowns have occurred in the western/southwestern Chicago suburbs due to continued or increased pumping. Drawdowns in the southwestern suburbs are more pronounced in communities located close to the Sandwich Fault Zone, which acts as a flow barrier. Drawdowns have also occurred around the Rockford area and regionally throughout Northwestern and Western Illinois.

Influence of Constructed Wetlands on the Local Groundwater Flow Regime of a Riparian Zone

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Constructed wetlands are being incorporated in agricultural settings to serve as a sink for excess nutrients associated with agricultural practices. The wetlands reduce nutrient, specifically nitrogen, concentrations through plant uptake and denitrification before discharging water into lakes, rivers, and streams. Questions exist as to how the wetlands alter the groundwater flow regime in the local area. Variation in the flow regime may influence the fate of nutrients in the subsurface. Temperature has the highest potential to explain the complex groundwater characteristics and model groundwater flow. Heat is transported in the subsurface by conduction and convection via groundwater flow. To assess how a wetland influenced the flow of groundwater, a wetland constructed in a riparian zone was monitored for a nine-month period. Water table elevations and groundwater temperatures were monitored within the wetland, a nearby stream, and within monitoring wells within the area to determine fluid flow and the velocity within the system. An initial review of the data shows that the wetland has altered the natural flow regime. While the underlying groundwater flow direction does not change, the presence of water within the wetland creates an area of recharge from which water appears to radiate in all directions. Currently a numerical model is being constructed to quantify the differences in discharge and velocity of the flow.

Determining the Effects of Physical Characteristics of Urban Storm Sewer Sheds on Water Quality in Bloomington, Illinois

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By Alicia O'Hare, Catherine O'Reilly, Kevin Kothe, Rex J. Rowley, and John Kostelnick

Increasing urbanization has consequences for surface water quality. Stormwater is a large component of urban water degradation that is poorly understood. Precipitation is quickly transported, via underground pipes, from the land to the stream without following water's natural flow path. Studies have correlated detention and retention ponds with improved water quality and the percentage of impervious surface cover with degraded water quality. However, other physical characteristics within a storm sewer shed including inlet density, and the presence of a sump pumps and percentage road area may also affect the stormwater quality. We chose 18 storm sewer systems in Bloomington, IL, to better understand impacts of storm water runoff. The areas contributing to each storm sewer system were delineated in ArcMap 10.2 and ranged from 185 m^2 to 2 km^2. Eleven of the storm sewer sheds were primarily zoned as residential, six were commercial and one was dominated by open land. We also considered roads as a zoning classification. Half of the storm sewer sheds include sump pumps, which prevent basement flooding. We measured pH, temperature, conductivity, dissolved oxygen, chloride, nitrate, phosphate, and total suspended solids. Relationships and differences among the physical characteristics and water quality were determined using correlation and ANOVA analyses. We found that the presence of a pond significantly improved water quality. We determined that as the percentage of impervious surface cover increase did not significantly alter water quality except chloride concentrations. As inlet density increased the water quality became degraded. Zoning did not have a significant effect on water quality. This research could contribute to how storm sewers are built and retrofitted in the future to decrease the water quality degradation from storm events.

An Introduction to the USGS Groundwater Toolbox: A Graphical and Mapping Interface for Analysis of Hydrologic Data

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The USGS recently released a new graphical and mapping interface for analysis of hydrologic data called the "Groundwater Toolbox". The toolbox was created by Paul Barlow (USGS hydrologist)to allow hydrologic scientists to gather and analyze all the data needed to calculate the components of the hydrologic budget for a given area. The toolbox retrieves hydrologic time-series data (streamflow, groundwater levels, and precipitation) from the USGS National Water Information System (NWIS) databases and from the National Oceanic and Atmospheric Administration National Climatic Data Center databases. The retrieved data is used in several applications available within the Toolbox. There are currently six hydrograph separation techniques—the Base-Flow Index (BFI Standard and Modified), HYSEP (Fixed Interval, Sliding Interval, and Local Minimum), and PART methods—and the RORA recession-curve displacement method and associated RECESS program to estimate groundwater recharge from streamflow data. The software interface also offers statistical packages, trend analysis, publication quality time-series graphs, and flow-duration curve graphs, as well as, the ability to create tables of the data being analyzed. Presentation-quality maps of the hydrologic area of interest can also be created. For additional information, please visit http://water.usgs.gov/ogw/gwtoolbox/.

The Use of Saline Springs and the Distribution of Chloride as Indicators of Recharge to and Groundwater Movement within the Illinois Basin

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Samuel V. Panno, Walton R. Kelly, Zohreh Askari and Thomas M. Parris

The Illinois Basin, initially developed on Precambrian crust, occupies most of Illinois, and parts of Indiana, Kentucky and Tennessee, and is filled with Cambrian through Pennsylvanian-age sedimentary rocks. Paleozoic sandstones and carbonate rocks in northern Illinois are productive aquifers; however, groundwater in these rocks have a high salinity in central and southern Illinois. Seigel (1989) and Cartwright (1970) suggested that groundwater generally flows toward the center of the Illinois Basin and discharged as upward leakage across confining units. However, details of recharge to and groundwater flow within the Illinois Basin on a basin scale are poorly understood. Our investigation involves the use of saline springs and geochemical cross sections to explore this question. In the course of this investigation, more than 40 locations of “mineral” and saline springs within and at the margins of the Illinois Basin were identified and investigated. Saline springs originate from Cambrian- to Pennsylvanian-age sedimentary rocks. Most springs were sampled for chemical and isotopic composition with emphasis on halide chemistry (Cl^-, Br^-, I^-). In addition, six cross sections across the Illinois Basin were prepared and included all available Cl^- concentrations to help evaluate local and regional groundwater movement into, within, and discharge from the basin. Of the springs identified and sampled, only 23 were naturally-occurring saline springs and saline anomalies (plumes of saline groundwater discharging within freshwater aquifers). These springs and anomalies (also referred to as “mineral springs” and “salt licks”) were recognized first by Native Americans and later by early settlers as good hunting grounds and a source of much-needed salt on the frontier. Settlers converted some of these springs into lucrative commercial ventures as a source of salt. Later many became the focal points of health spas and/or state parks. Others were abandoned and forgotten, or destroyed. In general, Cl concentrations of these springs are typically around 500 mg/L, but are as high as 30,000 mg/L. Cl/Br mass ratios that range from 150 to 700 and were used to identify the source formations of the saline spring water.

Overall, the saline springs of the Illinois Basin were found to be coincident with geologic structures within the basin and with basin margins to the south. Two major areas of saline anomalies stand out: 1) the La Salle Anticlinorium, and 2) the DuQuoin-Louden Anticlinal Belt possibly. Discharge along basin margins occur primarily in the southern end of the basin in Kentucky. The geochemical cross sections revealed active recharge to the basin from the north, west and east. Formations of low permeability (e.g., shales) tend to retain hypersaline brines, whereas formations with large permeability such as the St. Peter Sandstone tend to reflect focused recharge of fresh groundwater. A contour map of Cl concentrations of the St. Peter Sandstone was also prepared and revealed recharge areas (as above) and the effects of the LaSalle Anticlinorium on groundwater flow. The contour map suggests that the LaSalle Anticlinorium is providing a zone of greater permeability for groundwater movement from north to south. Structures are also important for downward movement of surface water and groundwater. Vertical pathways in the vicinity of the Ohio River in far southern Illinois where the river intersects the Cottage Grove Fault Zone appears to provide an avenue for recharge to near the base of Ordovician strata and groundwater movement south, into Kentucky.

Tracing Hydrocarbon Contamination through Hyperalkaline Environments in the Calumet Region of Southeastern Chicago

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The Calumet area of southeastern Chicago is a legacy to both industrialization and industrial blight. This area contained wetlands which were filled in with waste—especially slag—to make it suitable for development. The slag not only creates a heterogeneous underlying geology, but also produces a hyper-alkaline environment where the pH of the groundwater has been recorded as high as 13.3, surface water precipitates calcium carbonate sediment, and creates a unique and rare microbial environment. At an adjacent property is a decommissioned coking plant where creosotes, coke, and coal lie openly on the ground. As hydrocarbons weather, they degrade into characteristic polycyclic aromatic hydrocarbons (PAHs), unique to their original chemical composition. The goal of this research is to identify PAHs present in the nearby surface and groundwaters through use of gas chromatography/mass spectrometry (GC/MS) and to perform hydrocarbon forensic fingerprinting to determine if these organic compounds are influencing the alkaline environment. By comparing the ratios of target PAHs present to known compound profiles as well as suspected parent compounds from the site, the source of organic carbon in the adjacent alkaline sites may be identified. Microbial communities will be characterized by creation of a 16s DNA library, their carbon utilization patterns in Biolog Ecoplates, and 16s fingerprinting. As remediation efforts continue, understanding the geochemistry, weathering and decomposition, microbiology, and distribution of known contaminants is vital for effective local clean-up. PAHs, toxic to both humans and the environment, often serve as a target contaminant for remediation efforts. However, PAHs may also provide energy sources for the unique microorganisms present within the hyper-alkaline ecosystem. Investigating the geochemistry of this site is critical to ongoing research of the unusual microbiology and groundwater patterns in the area, as well as providing descriptive data in current and future remediation projects.

Capture Zone Analysis of a Shallow-Aquifer Irrigation Well in McHenry County, Illinois

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A groundwater flow model was developed to understand local groundwater flow systems impacted by an irrigation well within a shallow unconfined aquifer in McHenry County, Illinois. Municipal and domestic water supplies in the county are extracted exclusively from groundwater and largely from shallow sand and gravel aquifers. Thus, the county has taken an aggressive approach to understanding these shallow aquifer systems though regional mapping and flow models. The shallowest, unconfined aquifers, from which many irrigation wells extract groundwater, are comprised of sand and gravel that fill former glacial outwash valleys. A local groundwater flow model was constructed to address the potential impacts of drawdown on groundwater quality and stream discharge. This model can be used as a tool to determine current impacts of pumping on shallow aquifer systems and to estimate long-term effects.