Groundwater and Geothermal Resources Seminar Series

1PM, Friday, November 2, 2018
Monsanto Multimedia Studio, ACES Library
1101 S Goodwin Ave, Urbana, IL 61801
Lower Level Room 008

Refreshments provided beginning at 12:45pm

Hosted by:
Illinois Water Resources Center, University of Illinois Extension

Sponsored by:
Lemann Institute for Brazilian Studies
Illinois State Geological Survey, Prairie Research Institute

IWRC ILLINOIS WATER RESOURCES CENTER

iwrc@illinois.edu

382 NSRC, MC-635
1101 W. Peabody Dr.
Urbana, Illinois 61801

217-300-2101

1:05pm - Seminar #1:

Insights on low-temperature geothermal from Indiana—critical questions of system design at the district scale

Lee Florea, Indiana University

Ongoing geothermal research within Indiana has focused upon the response of shallow geologic media to thermal loading, a critical design aspect of ground-coupled heat pumps (GCHPs). District-scale heating and cooling systems, such as those at major universities are particularly prone to lost efficiency due to unbalanced thermal loading. Summaries of three research programs are provided in this brief presentation: 1) evidence of legacy heat lost in the subsurface at Indiana University from a century of thermal 'leakage' from the campus distribution system; 2) Thermal capacity of soils and seasonal heat transfer in the critical zone measured across the Indiana Water Balance Network, and 3) thermal loading in the subsurface of Ball State University following the launch of their campus-wide GCHP.

Lee is the Assistant Director of Research of the Indiana Geological and Water Survey and a licensed professional geologist in Indiana and Kentucky with two decades of professional experience in academic, government, and industry. His research spans the natural sciences as they pertain to the understanding of carbonate aquifers—groundwater that influences the drinking water of one out of every four people on Earth. An avid caver, cartographer, and a certified advanced diver, Lee has visited and surveyed throughout North America, Europe, and the Caribbean. His current research questions focus on carbon transport in the critical zone, and includes funded research programs in Indiana, Kentucky, Miami, Mt. Rainier, and Romania. Lee arrived at the Survey after 8 years as tenure line faculty in Kentucky and Indiana. He is a Romania Fulbright Fellow and a USGS Mendenhall Postdoctoral Scholar. He received his PhD from the University of South Florida and his MS from the University of Missouri-Columbia. His undergraduate in Physics and Mathematics is from Western Kentucky University.

1:30pm - Seminar #2:

Recovery Time of Ground Temperature After Heating Tests on Energy Piles in Unsaturated and Saturated Brazilian Soils

Cristina de Hollanda Cavalcanti Tsuha, University of São Paulo, Brazil

Energy piles are deep foundation structures which have been used as ground heat exchangers for air heating and cooling of buildings in different countries. However, the performance of these systems in Brazil is not known yet. Because of its tropical and subtropical climate, the consumption of electrical energy for air-cooling systems in Brazil is very high. Therefore, the use of ground source heat pump (GSHP) systems with energy piles seems to be an interesting alternative to address this problem.

Due to the climatic conditions, the heat exchange operations in Brazil are likely to result in the progressive heating of the ground. On the other hand, the groundwater flow rate are fundamental to permit the ground temperature recovery around the heat exchanger piles after periods of heat rejection in the ground.

Therefore, to investigate the effect of some local peculiarities of the use of energy foundations in Brazil, as the use of this system only for air cooling (no heat extraction, as normally occurs in temperate and cold climate countries) and higher ground temperatures, an experimental study have been carried out at two different sites in the State of Sao Paulo.

In the first site, an energy pile was installed in an unsaturated soil, which is the most critical condition of ground temperature recovery after the continuous use of GSHP systems. In the second site, an energy pile will be installed in a saturated sand soil, with high groundwater flow rate, which should be the most favorable condition for the ground temperature recovery, and consequently in this case the heat exchanger efficiency may be better compared to the case of pile in unsaturated soil.

This presentation describes the first results of the ground temperature recovery around a tested energy pile in the unsaturated soil site, and the experimental programme designed to study the effect of groundwater flow rate on the energy pile installed in the saturated sand site.

Dr. Cristina Tsuha is an Associate Professor in the Department of Geotechnical Engineering at the University of São Paulo (São Carlos, Brazil). After graduating in 1994, she worked as civil engineer in multiple engineering companies for six years during which time she was involved in multiple projects related to geotechnical site investigations, foundations, and earth structures. In 2001, after this period of practical working experience, she returned to the University to complete a Master's followed by a Doctorate in Geotechnical Engineering at the University of São Paulo. In 2009, after finishing the doctoral thesis, she completed her post-doc at the Laboratoire 3S-R (INPG-Grenoble - France) where she did model pile tests carried out in a calibration chamber. Her current research focuses on the study of Foundations Engineering, with emphasis on the following topics: (i) helical pile foundations, (ii) physical modelling of pile behavior, (iii) reliability analysis of pile and shallow foundations, (iv) geothermal energy pile foundations.

iwrc@illinois.edu

382 NSRC, MC-635
1101 W. Peabody Dr.
Urbana, Illinois 61801

217-300-2101

2:00pm - Seminar #3:

Integrated regulation of (geo)thermal subsurface use(s) and groundwater

Corinna Abesser, British Geological Survey, United Kingdom

Hydrogeology and groundwater regulation have always played an important role in geothermal energy, specifically in the exploration and development of high enthalpy (deep) geothermal resources. More recently, hydrogeological involvement and regulations have expanded to include the development of ground-coupled heat-pump based systems that provide space heating and/or cooling.

In the UK, groundwater regulations are the main mechanism to control the operation of such systems. Currently, regulations only apply to systems which make direct use of groundwater as heat exchanger medium (open-loop systems) via abstracting / re-injecting groundwater as part of the heating/ cooling process, whereas systems which extract heat indirectly (closed-loop systems) by circulating a heat exchanger fluid through pipe loops installed in the subsurface remain largely unregulated. However, these systems can have considerable impact on heat availability and temperature distributions within the subsurface, specifically where groundwater flow is present, and thus regulatory mechanisms need to be put in place that provide better controls on the use of subsurface thermal resources via these systems.

This presentation demonstrates potential impacts of high-density closed loop installations on groundwater temperatures and on the availability of thermal resources. It looks at current regulatory approaches for heat abstraction in the subsurface, in the presence/ absence of groundwater resources, and presents arguments and solutions for integrated regulatory approaches that can manage the increasing use of subsurface heat and groundwater resources by ensuring resource sustainability on the one hand without compromising stakeholder / investor confidence on the other hand.

Dr. Corinna Abesser is the leader of the new Geothermal Program at the British Geological Survey. Since completing her MSc in Hydrogeology and PhD in Hydrochemistry, Dr. Abesser has had various professional roles including Hydrogeologist, Hydrogeochemist and Groundwater Modeller. Corinna has recently taken over the role of the Geothermal Energy Team Leader at the British Geological Survey, and is overseeing and expanding BGS' portfolio of national and international projects on shallow and deep geothermal systems.

2:25pm - Seminar #4:

Radiators or reservoirs: Heat budgets in groundsource geothermal fields

David J. Hart, University of Wisconsin

Ground source heat pump geothermal has potential to provide low-cost long-term heating and cooling over a range from single homes to district-scale. As the scale of the geothermal system increases from a single ground heat exchange (GHE) boring for a home to several thousand GHEs for a district scale facility, overheating of the exchange field becomes a possibility. Larger facilities generally cool their buildings more than heat them, resulting in more heat discharged to the exchange field than removed annually. In addition, because thousands of borings are often placed in a single exchange field, neighboring GHEs superimpose their temperature increases on each other reducing their ability to transmit heat to the field.

To understand these issues, we are studying a district-scale exchange field in Verona, Wisconsin. This field and heat pumps supply heating and cooling for a campus of approximately 10,000 employees. We are collecting geologic and temperature data that allows us to determine the heating budget for the field. That budget consists of 1. heat moved into and out of the field by the BHEs, 2. changes in heat stored in the field, and 3. heat flow out of the field into the surrounding rock and air. This budget will then allow us to understand how the field is behaving. If it is a reservoir, then the heat flow from BHEs should equal the change in heat storage with little flow out of the field into the environment. If the field is a radiator, then the heat flow from the BHEs should equal the heat flow out of the field into the environment with little change in the heat stored in the field.

Early results suggest that the field is more of a reservoir than radiator. The geometry of the field and BHEs and the imbalanced heating and cooling loads require that the field be routinely reconditioned or cooled. It is receiving more heat than it can dissipate and will need to be conditioned by water from a cooling pond to maintain cooler temperatures and efficiency over the long-term use of the field.

David J. Hart is a Professor in the Department of Environmental Sciences in the University of Wisconsin-Extension and a hydrogeologist and geophysicist for the Wisconsin Geological and Natural History Survey (WGNHS). His current research projects include the hydrogeology of wetlands and groundwater/stream interactions. He is also interested in developing methods using geophysics to determine depth to bedrock and understanding fracture flow in rock. He received his BA from Luther College in Iowa and his PhD from the University of Wisconsin-Madison.

2:50pm – BREAK

3:10pm - Seminar #5:

The Groundwater-Energy Nexus in Sedimentary Basins

Grant Ferguson, University of Saskatchewan, Canada

Sedimentary basins offer intriguing opportunities for geothermal development. Deep aquifers capable of supporting high capacity production and injection wells are common. In many environments, a long history of oil and gas development provides a framework for exploration that is not possible in other areas. However, competition with other subsurface uses is an issue. Enhanced oil recovery and saltwater disposal are likely causing decreases in the temperatures of many reservoirs. Large-scale injection required for geothermal projects may lead to other issues, including transport of brines into overlying groundwater supplies and induced seismicity. Coordinated management of the subsurface is required to allow geothermal development to proceed in sedimentary basins.

Grant Ferguson is an Associate Professor and Chair of the Geological Engineering program at the University of Saskatchewan. He holds a BSc in geology from the University of Waterloo and a PhD in Civil Engineering (Hydrogeology) from the University of Manitoba. Dr. Ferguson is the chair of the International Association of Hydrogeologists Groundwater and Energy Commission.

3:35pm - Seminar #6:

Reversing Thermal Ground Conditions to Achieve Energy Sustainability

Robert A. Schincariol, University of Western Ontario, Canada

Viewpoints on energy resource recoverability and geoexchange systems vary considerably amongst the various professions that work in this field. In some cases, groundwater flow is assumed negligible and the subsurface is viewed as a perfect storage and recovery 'black box'. Focus is on borehole heat exchanger (BHE) design, often down to factors affecting loads at the single percent level. However, when BHE's are considered in a hydrogeological context, focus is on ground conditions, where uncertainty and groundwater flow conditions can affect performance at levels exceeding 10 to 20%.

Research underway using the modeling software FEFLOW, with the BHE and piFreeze plug-ins, illustrates how coupling hydrogeology and BHE design can help address energy sustainability issues. While core issues of considering groundwater flow in typical BHE field design remain, the focus is on two 'end-member' problematic zones for geoexchange systems. Work on BHE's accessing deep medium-temperature anomalies, and shallow systems in discontinuous permafrost will be reviewed. Both present novel opportunities to reverse thermal ground conditions, recover waste heat, and better achieve energy sustainability.

Rob is a Professor of Hydrogeology, cross-appointed to the departments of Earth Sciences and Civil and Environmental Engineering at the University of Western Ontario. His research interests are in physical hydrogeology with a focus on heat transport, low-temperature geothermal energy, permafrost hydrogeology, and variable-density flow. He currently is an Executive Editor for the journal *Groundwater*, and regularly serves as a consultant to government and industry.

4:00pm - Seminar #7:

Energy Resilience Enables Army and DoD Readiness

Franklin H. Holcomb, U.S. Army Corps of Engineers

The Army and Department of Defense (DoD) are improving energy resilience and security at military installations worldwide. These locations provide the vital infrastructure to organize, train, equip, and deploy Soldiers. Secure and reliable access to energy, water, and land resources is vital for the Army and DoD to perform its mission and support global operations. AR 600-20 dated 06 November 2014 defines resilience as, “The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. Army Directive 2017-07 (Installation Energy and Water Security Policy) states that, “The Army will reduce risk to critical missions by being capable of providing necessary energy and water for a minimum of 14 days.” This Directive further states that the Army will improve resilience at installations by addressing, “Redundant and diverse sources of supply, including renewable energy and alternative water, that meet evolving mission requirements during normal and emergency operations.”

Geothermal energy is a renewable energy resource using heat that is available from the Earth. Geothermal energy is often thought of in terms of energy savings and in many cases being life cycle cost effective. Some case studies of geothermal energy implementation at Army and DoD installations will be presented, with an emphasis on the potential for improving energy resilience. Given the Army and DoD requirements, policy, and directives towards improving resilience and readiness, geothermal energy utilization could play a part of a holistic solution to meeting these requirements and directives.

Mr. Holcomb is an Associate Director in the Office of Technical Directors at the U.S. Army Engineer Research & Development Center, Construction Engineering Research Laboratory (ERDC-CERL), located in Champaign, IL. Mr. Holcomb has over 25 years of experience in leading energy and sustainability technology projects for the U.S. Army and Department of Defense. Mr. Holcomb has B.S. and M.S. degrees in Engineering and Physics, and he is currently pursuing a PhD in Civil and Environmental Engineering at the University of Illinois.

4:25pm – Seminar #8:

Geothermal research at UIUC: Geoexchange applications, feasibility of DDU, and future possibilities

Andrew Stumpf, University of Illinois

With the increasing interest in using the near constant temperatures in the ground for heating and cooling applications, there is a growing need to better understand the dynamics of the subsurface thermal profile in order to optimize the efficiency of geothermal systems. At the University of Illinois at Urbana-Champaign campus, faculty and students are working on a number of projects related to this research. About a year ago, the University of Illinois was awarded a grant from the U.S. Department of Energy to study the feasibility of utilizing Deep Direct Use geothermal energy from deep aquifers in the Illinois Basin to heat and cool agricultural research facilities along ACES Legacy Corridor. The researchers have also been successful in obtaining grants from the campus Student Sustainability Committee to install the Geothermal Research Station, build a thermal response test system, and help design a geothermal system to heat and cool several greenhouses for biofuel research and food production. They are also senior personnel in a National Science Foundation Critical Zone Observatory studying the impacts of surface and subsurface temperatures on the hydrological, geochemical, and biological systems in intensively managed landscapes.

Dr. Andrew Stumpf is a Geologist at the Illinois State Geological Survey, a division of the Prairie Research Institute at the University of Illinois at Urbana-Champaign (UIUC). Andrew is also an Adjunct Professor at the University of Waterloo and Illinois State University. For the past 20 years, Andrew has undertaken geological investigations in the glaciated regions of North and South America with a focus on characterizing the geologic materials to help answer basic and applied science questions. Specifically, he has led studies to address water supply and water quality issues, and is currently co-leading a new geothermal research initiative at UIUC.