



THE SINKHOLE CONFERENCE

Multidisciplinary Conference on Sinkholes and the
Engineering and Environmental Impacts of Karst

Program with Abstracts 18th Sinkhole Conference

October 5–9, 2026

Albany Capital Center

Albany, New York



“Integrating Science and Engineering to Solve Karst Problems”





Multidisciplinary Conference on Sinkholes and the
Engineering and Environmental Impacts of Karst

The 18th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst

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Table of Contents

Table of Contents.....	1
Program At-a-Glance.....	2
Organizing Committee.....	3
Sponsors.....	4
Short Courses.....	5
Detailed Program.....	9
Keynote Speaker.....	11
Banquet Speaker.....	12
Presentation Abstracts.....	13
Poster Abstracts.....	19
Karst Clips.....	22

Front cover: sinkhole with snow. Photo courtesy of John Dunham.

Back cover: sinkhole in the McFails Cave Nature Preserve. Photo courtesy of John Dunham.

Program At-a-Glance

	Monday, October 5, 2026	Tuesday, October 6, 2026	Wednesday, October 7, 2026	Thursday, October 8, 2026	Friday, October 9, 2026
8:00-9:00 am	Field Trip	AM Short Courses	Coffee and Registration	Coffee Discussions	Field Trip
9:00-10:00 am			Keynote Speaker	Presentations	
10:00-11:00 am			Presentations		
11:00-12:00pm					
12:00-1:00pm		Lunch Break	Lunch Break	Banquet & Speaker	
1:00-2:00 pm					
2:00-3:00 pm		PM Short Courses	Presentations	Karst Clips	
3:00-4:00 pm					
4:00-5:00 pm					
5:00-6:00 pm			Poster Session		
6:00-7:00 pm		Welcome Reception			
7:00-8:00 pm					

Organizing Committee

Task	Coordinator(s)
Conference Co-Chairs	Ben Tobin, Keith White, Jim LaMoreaux
Communications	Devra Willingham
Administration	Valerie Davis
Speakers	Ira Sasowsky
Sponsors	Robert Denton
Publications	Peter Hutchinson
Website Hosting and Maintenance	Gheorghe Ponta, Devra Willingham
Program with Abstracts	Matthew Kaspar, Devra Willingham
At-Large Members	Brad Stephenson, Brian A. Smith, Calvin Alexander, Clint Kromhout, Connie Campbell-Bradshear, David Harro, David Decker, Daniel H. Doctor, Jennifer (Adkins) Schudrowitz, John Barry, Mia Painter, Nick Lawhon, Tyrone Black, Wanfang Zhou, Yongli Gao



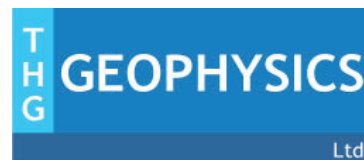
Karst spring in Schoharie County, New York. Photo courtesy of Keith White.

Sponsors

Each Sinkhole Conference relies on the vital support of our sponsors. Thanks to their generous backing, we are able to keep registration fees low and ensure our event is accessible to the entire community. Please find our sponsors to show your appreciation and support.



HANGLEY ARONCHICK
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Short Courses (Tuesday, October 6)

Each course is eligible for 4 professional development hours, approved by the New York State Council of Professional Geologists.

Short Course 1: Contaminant Transport in Karst

Keith White (Arcadis U.S.)

Room: MR 1

8:00 am – 12:00 pm

Summary:

Karst terranes provide unique challenges to professionals faced with characterizing, managing, and remediating sites impacted by regulated substances. Groundwater flow and chemical transport in karst may be complicated by conduits that are difficult to locate, turbulent flow, extreme geologic heterogeneity, dual-porosity and dual-permeability regimes, and sediment transport. Because of these complexities, widespread knowledge and understanding of contaminant hydrogeology of karst is limited. Furthermore, up to 25% of the world's population depends on waters derived from karst aquifers.

This intermediate-level short course focuses on contaminant hydrogeology of karst and is intended for participants who already have a basic understanding of hydrogeology. The target audience is professionals faced with or interested in the subject.

Relevant topics include: Conceptual Models; Multiphase Flow; Fate and Transport of Dissolved Compounds, Metals, and Pathogens; Monitoring and Characterization Techniques; Remediation and Management; Role of Clastic Sediment in Contaminant Storage, Transport, and Attenuation

Course attendees will gain a working knowledge of:

- The fundamentals of karst hydrogeology
- Characteristics of the primary contaminants to karst aquifers
- The major sources of contamination to karst aquifers, modes of storage and transport, and typical receptors
- Current status of quantitative modeling of groundwater flow and contaminant transport in karst
- Approaches and strategies for characterizing, remediating, and managing contaminated sites in karst terranes
- In addition, attendees will receive a comprehensive bibliography citing nearly 100 benchmark papers and other key sources of information relevant to karst hydrogeology



Photo: Keith White, Arcadis

Role of Clastic Sediment in Contaminant Storage, Transport, and Attenuation

Short Course 2: Karst Database Development: Techniques for Managing Large Volume Karst Data Sets

Dave Decker, PhD, PG, CPG (Southwest Geophysical Consulting, LLC)

Dan Doctor, PhD (U.S. Geological Survey)

Room: MR 2

8:00 am – 12:00 pm

Summary:

Collection of karst data in the field is very challenging and is often done by non-karst experts in an unstructured fashion. Assigning unique inventory control numbers to each feature and then associating feature type, size, applicable notes, and other significant attributes (including field photos) to these features when multiple field campaigns are occurring simultaneously can be challenging. This short course is designed to demonstrate a strategy that can facilitate the move toward standardization of the types of data collected in karst areas, how those data may be structured within a relational, GIS-focused database, and then easily associated with previous or future data sets for inclusion in current and follow on projects.

Course attendees will gain a working knowledge of:

- The minimal information needed for a comprehensive karst feature inventory inclusive of sinkholes, springs, dye traces, and caves (where admissible)
- Assignment of basic attribute information to provide additional value to the inventory of karst features
- How to associate these features in a GIS relational database format
- Some examples of karst feature datasets from different areas in the U.S.

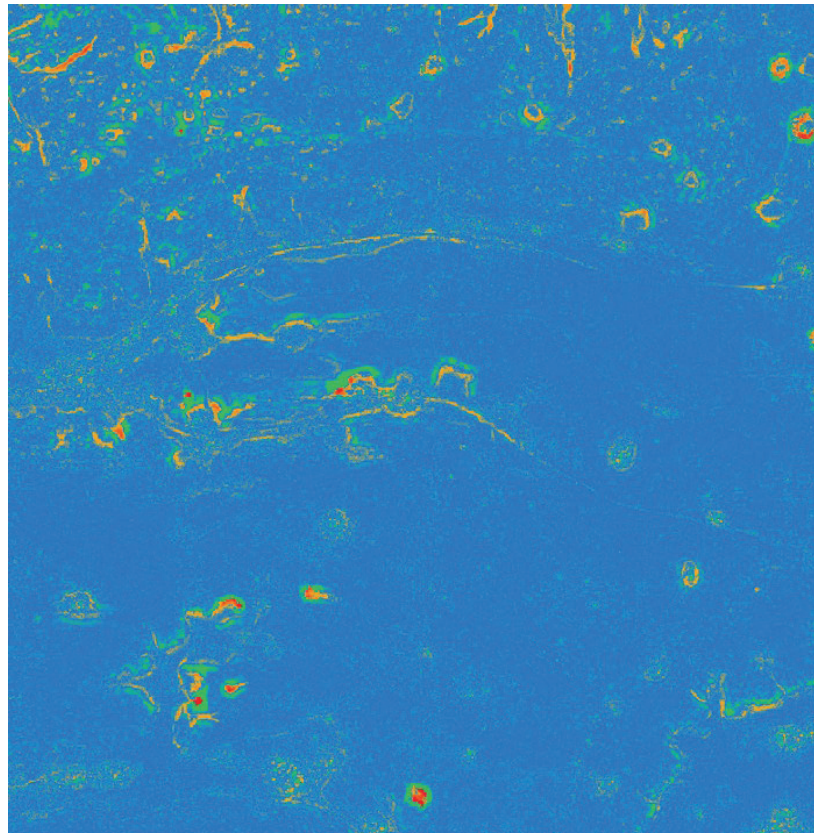


Image: Southwest Geophysical Consulting, LLC



Photo: Aaron Beirl, Southwest Geophysical Consulting, LLC

Short Course 3: When Sinkholes Become Legal Pitfalls: “Sinkhole Law” and How to be an Indispensable Expert Witness

Peter Keays, JD (Hangley, Aronchick, Segal, Pudlin, & Schiller)

Steve Miano, JD (Hangley, Aronchick, Segal, Pudlin, & Schiller)

Ira Sasowsky, PhD, PG (University of Akron)

Room: MR 1

2:00 pm – 6:00 pm

Summary:

It's no mystery that sinkholes often create significant legal issues of various stripes, but the nature of those issues and how they are resolved is far less obvious. This course will demystify the legal dimensions of sinkholes in a way that is accessible to non-lawyers and provide a scientific and technical audience with practical guidance on how to be an effective advisor, consultant, or expert witness in the legal realm. The course is designed to be highly engaging, with case studies and audience participation throughout.

The first portion of the course will provide a primer on the types of legal issues that can be implicated when a sinkhole occurs. This will include an explanation of the various claims that can be brought by nearby property owners and other parties impacted by a sinkhole, the elements that must be proven for each claim, and the types of damages and other remedies that are available. We will also cover the various types of legal recourse available to regulators and nearby property owners when addressing or attempting to prevent sinkholes, including permit conditions and modifications, enforcement actions, settlement agreements, and (if all else fails) litigation. Throughout this portion, particular emphasis will be placed on the concept of causation, which is a critical but complicated component of most claims, and is an area in which effective expert work is essential.

The second portion of the course will cover the role and effective use of technical experts and impart practical guidance to successfully navigate the legal world. Topics will include: tips for working with lawyers; what makes a great expert; the importance of terminology; communicating complex technical topics to lay audiences—including judges—through effective expert reports, visuals, and testimony; how to prepare for and survive a deposition or cross-examination; addressing unfavorable facts and contrary opinions by experts “on the other side;” and avoiding common pitfalls throughout the process.

The course will conclude with a group exercise intended to immerse attendees in these concepts and give them the opportunity to put what they've just learned to use.



Photo: Ira D. Sasowsky

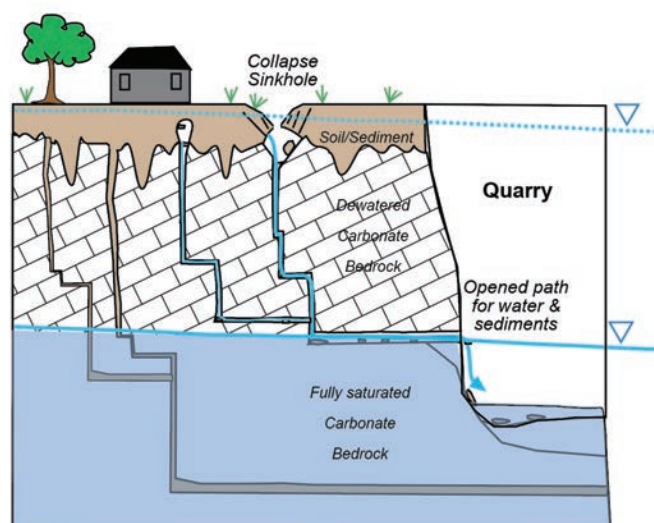


Figure: Ira D. Sasowsky

Short Course 4: Modern Techniques in Sinkhole Data Collection, Analysis, and Use

Michael Jones, MS, PG (Southwest Geophysical Consulting, LLC)
Joshua Valentino, PhD, PG (Terracon Consultants)

Room: MR 2

2:00 pm – 6:00 pm

Summary:

Sinkhole investigations have evolved rapidly over the past decade due to advances in remote sensing, GIS, and data management. This half-day short course offers a practical, comprehensive overview of modern strategies for identifying, verifying, and applying sinkhole and karst feature data in environmental, engineering, and land-management contexts.

The course begins with a concise review of karst and sinkhole fundamentals, covering geologic settings that favor sinkhole formation and the range of surface karst features encountered in practice. Participants are then introduced to contemporary desktop reconnaissance techniques, including the use of aerial imagery, LiDAR-derived products, and existing datasets to identify and prioritize potential sinkholes before fieldwork begins.

Building on the desktop phase, the course covers field data collection and verification strategies, emphasizing efficient methods for confirming sinkholes, distinguishing karst from non-karst features, and documenting observations to support defensible decision-making. Advanced techniques, such as drone-based imagery and surface modeling, will be introduced, with discussion of their best-use scenarios and integration with traditional fieldwork.

The latter portion of the workshop focuses on data cataloging, GIS workflows, and long-term data management. Participants will learn how sinkhole datasets are structured, maintained, and translated into practical products such as maps, buffers, and constraint layers. Real-world examples will illustrate how these data support engineering design, environmental permitting, hazard assessment, and land-management decisions.

The format is interactive and discussion-based, emphasizing transferable techniques that attendees can apply to their own projects.



Photo: Isaac Estep, Terracon, LLC



Photo: Joshua Valentino, Terracon, LLC

Monday October 5

7:30 AM	5:00 PM	Field Trip - Karst Hydrology of the Northern Fox Creek Upland; East Central New York State, USA. Trip Leaders: Paul Rubin, George Shaw, Robert Simmons <i>(departs from Albany Capital Center)</i>
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Tuesday October 6

		Short Courses
8:00 AM	12:00 PM	Short Course 1: Contaminant Hydrogeology of Karst, Instructors: Keith White (MR1)
8:00 AM	12:00 PM	Short Course 2: Karst Database Development: Techniques for Managing Large Volume Karst Data Sets, Instructors: Dave Decker, Dan Doctor (MR2)
12:00 PM	2:00 PM	Lunch (2 hours)
2:00 PM	6:00 PM	Short Course 3: When Sinkholes Become Legal Pitfalls: "Sinkhole Law" and How to be an Indispensable Expert Witness, Instructors: Peter Keays, Steve Miano, Ira Sasowsky (MR1)
2:00 PM	6:00 PM	Short Course 4: Modern Techniques in Sinkhole Data Collection, Instructors: Michael Jones, Joshua Valentino (MR2)
6:00 PM	8:00 PM	Welcome Reception

Wednesday October 7

8:00 AM	9:00 AM	Coffee and Registration
9:00 AM	9:20 AM	Welcome and Introductions
9:20 AM	10:20 AM	Keynote: Thomas Reimann, PhD - Advancing Discrete–Continuum Modeling of Flow and Transport in Karst Systems Across Scales
10:20 AM	10:40 AM	Break (20 minutes)
		Hydrology
10:40 AM	11:00 AM	U. Tulsiani, J. M. Tillotson, A. Nelan, K. A. White - Remediating Groundwater in a Karst Terrane – Encouraging Results and Lessons Learned
11:00 AM	11:20 AM	M. Kaspar, B. Tobin, M. Furtner - A Simple Approach to Assessing Groundwater Discharge Behavior at Government Spring, Central New Mexico
11:20 AM	11:40 AM	L. A. Bledsoe, C. Groves, N. Lawhon - Ongoing Dye Tracing Prompts Major Reevaluation of Groundwater Divides for the Lost River Karst System, Bowling Green, KY, USA
11:40 AM	12:00 PM	B. A. Smith - Stratigraphic Controls on Recharge to the Confined Aquifer of the North Coast Karst Belt of Puerto Rico
12:00 PM	2:00 PM	Lunch (2 hours)
		Northeast Karst
2:00 PM	2:20 PM	D. H. Doctor, J. R. Benton, M. A. Briggs, W. E. Odom, N. C. Terry - Springs of the Catskill Mountains: A Conduit Flow System in Predominantly Siliciclastic Strata
2:20 PM	2:40 PM	I. D. Sasowsky - Karst at a Potential Construction Site Adjacent to the Delaware River Near the Glacial Terminus, New Jersey, USA
2:40 PM	3:00 PM	M. Painter, S. Welsh - Karst Sinkholes and Civil Engineering: Overview of Characterization and Treatment Options from a Geophysical and Geotechnical Viewpoint
3:00 PM	3:20 PM	Break (20 minutes)
		Geomorphology
3:20 PM	3:40 PM	J. R. Steenberg, J. D. Barry, A. J. Retzler, A. C. Runkel, R. G. Tipping, E. C. Alexander, Jr. - A Comprehensive Analysis of Stratigraphic Influence on Karst Feature Distribution and Density Across Southeast Minnesota, USA
3:40 PM	4:00 PM	P. J. Hutchinson - Hasparos Embayment - An Example of Intrastratal Hypogenic Speleogenesis
4:00 PM	4:20 PM	S. Ahmed, S. McGary - Contrasting the Groundwater Pathways Driving Cave Formation in the Water Sinks Area in Highland County, Virginia, USA Using Electrical Resistivity Imaging
4:40 PM	5:00 PM	D. D. Decker, G. Jorgensen Olague, M. Jones, R. Palmer - Brine-Enhanced Hypogenic Speleogenesis and Concentrated Karst Development in the Burton Flats, Eddy County, New Mexico

Thursday October 8

8:00 AM	9:00 AM	Coffee Discussions
		Sinkhole Mapping
9:00 AM	9:20 AM	O. M. Al-Tarawneh, W. Zhan, C. Kromhout - Statewide Sinkhole Susceptibility Mapping in Florida Using Explainable GeoAI
9:20 AM	9:40 AM	M. Puente-Sierra, J. Santos-González, R. B. González-Gutiérrez - Comparing Manual and Automated Methods in Sinkhole Delineation: A Cantabrian Mountains (Spain) and Tasman Mountains (New Zealand) Case Study
9:40 AM	10:00 AM	J. Zhu, D. Cunningham, N. Jacobs - Attention-Enhanced Multimodal Fusion of Elevation and Aerial Imagery for Sinkhole Segmentation
10:00 AM	10:20 AM	Break (20 minutes)
		Geospatial
10:20 AM	10:40 AM	N. Lawhon - Cover Collapse Sinkholes in Stormwater Infrastructure in the Urban Karst of Bowling Green, Kentucky – Occurrence, Mitigation, and Prevention
10:40 AM	11:00 AM	B. Parrick, D. Aden - A Comprehensive Look at Ohio's Karst Inventory Mapping Reconnaissance, Ground-Truth, and Beyond
11:00 AM	11:20 AM	J. D. Barry, R. C. Spong, P. J. Hutchinson, M. R. Larsen, A. C. Runkel - Characterization of the Galena Karst of East-Central Olmsted County Minnesota
11:20 AM	11:40 AM	D. B. Wijesinghe, S. Schmidt - Investigating Sediment Accumulation Dynamics via Integration of GIS and Remote Sensing Tools Along with Physical/Chemical Characteristics of Sediments in Owl Cave, Highland County, Virginia
11:40 AM	12:00 PM	Break (20 minutes)
12:00 PM	2:00 PM	Banquet and Speaker: Michael Sukop, Ph.D., PG, CHG - A Bellwether for Change: Groundwater and Sea Level Rise in Southeast Florida
2:00 PM	4:00 PM	Karst Clips
4:00 PM	7:00 PM	Poster Session
4:00 PM	7:00 PM	Jenny Huang, Jannes Kordilla, Marco Dentz, John Barry, Christian Langevin, Peter Kang - A Field-Inspired Investigation of Conduit Network Impacts on Spring Flow in Karst Aquifers
4:00 PM	7:00 PM	Robert Salaz, Jacob Slyder, Ellen Trautner, Georgia Schneider - Mobile LiDAR Scans of Caves; Methods for Tying in Ground Control Points
4:00 PM	7:00 PM	Mary C. Ngoma, Oladoyin Kolawole - Biogeomechanics of EICP Reinforcement of Karstified Rock Masses
4:00 PM	7:00 PM	Zachary C. Schagrin - Creating a Karst Features Map of a 7.5-Minute Quadrangle in Northern New Jersey
4:00 PM	7:00 PM	Enzo Franceschi Genesi, Horia G. Olariu, Bradford Wilcox - Mapping Sinkholes and Closed Depressions in the Edwards Aquifer Recharge Zone: Comparizon of LiDAR-Based Semi-Automated Detection Methods and Field Validation
4:00 PM	7:00 PM	Jennifer R. (Adkins) Schudrowitz, Linda K. Bevis - Production Variability in the Edwards Aquifer, South-Central Texas, USA
4:00 PM	7:00 PM	Oladoyin Kolawole, Rita L. Sousa, Christina Comuso, Mohab Hussein - Sinkhole Hazards, Risks and Remediation: A Fifty-Year Case Study in New Jersey, USA

Friday October 9

7:30 AM	1:00 PM	Field Trip - Geology of Howe Caverns. Trip Leader: Sarah Cadieux <i>(departs from Albany Capital Center)</i>
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Keynote Speaker: Thomas Reimann, Ph.D.



Advancing Discrete–Continuum Modeling of Flow and Transport in Karst Systems Across Scales

Abstract

Karst systems are characterized by pronounced heterogeneity and anisotropy. The dual nature of karst, for example the coexistence of laminar and turbulent flow or diffuse and concentrated recharge, further increases complexity. Flow and transport processes are additionally controlled by discrete conduits interacting with the surrounding fractured rock matrix. Therefore, process-based numerical modeling requires advanced approaches capable of representing conduit–matrix interaction while remaining applicable across a wide range of spatial scales. This keynote presents recent advances in discrete–continuum modeling of karst systems using the MODFLOW Conduit Flow Process (CFPv2). Particular emphasis is placed on open and reproducible Python-based workflows that integrate model pre-processing, simulation, and post-processing within a script-based environment. The modular workflow further enables the integration of external tools, such as stochastic conduit network generators. This facilitates systematic parameter studies, comprehensive investigations of structural uncertainty, and

applied groundwater modeling, enabling efficient and systematic analyses of both flow and transport processes. Model applications ranging from synthetic benchmark studies in a virtual karst laboratory to practical groundwater management problems, including Managed Aquifer Recharge, demonstrate how these workflows support process understanding, model evaluation, and karst system characterization. The presentation highlights how combining physically based discrete–continuum models with open computational workflows provides new opportunities for investigating karst systems across scales and supporting more reliable numerical modeling for research and groundwater management.

Biography

Thomas Reimann is a researcher and lecturer at the Institute for Groundwater Management at TU Dresden, Germany. With nearly 20 years of experience, Thomas' work focuses on groundwater engineering, often in combination with distributed numerical models in different environments, e.g., karst systems and groundwater management in open-pit lignite mining. He received a diploma in water management with a focus on groundwater engineering from TU Dresden in 2003. In 2012, he was awarded the degree of Dr.-Ing. (Ph.D.) in groundwater management by TU Dresden for his research on karst systems. Thomas is a specialist in applying and adapting distributed numerical models for use in research and industry. He enhanced the distributed numerical discrete-continuum model MODFLOW Conduit Flow Process (CFP) with various boundary conditions, as well as flow and transport processes in CFPv2. Current research projects comprise karst system characterization using inverse groundwater modeling, groundwater management in open-pit mining environments, and Managed Aquifer Recharge. Besides research, he has been actively teaching groundwater management and groundwater modeling since 2003 at TU Dresden and has served as a guest lecturer in Hydrogeology at the University of Gothenburg (Sweden) since 2017. He also serves as Manager of Digital Education for The Groundwater Project, where he coordinates the development of interactive educational tools and digital learning initiatives for the international groundwater community. His ongoing teaching activities use various innovative digital methods to improve learning, which was honored by the TU Dresden Teaching Award in 2017.

Banquet Speaker: Michael Sukop, Ph.D., PG, CHg



A Bellwether for Change: Groundwater and Sea Level Rise in Southeast Florida

Abstract

Interactions between post-glacial sea level and groundwater likely sculpted the current landscape of Southeast Florida. Following a stabilization of sea level 7,000 years ago, which has been credited with an explosion of complex human societies, sea levels are on the rise again in Southeast Florida, and groundwater is rising along with it. As in many low-lying coastal areas, this means there is less room for stormwater storage in the subsurface. A groundwater-centric view of flooding may be appropriate in many of these environments, and a preliminary assessment of this approach is presented. Dense urban development near the shore severely limits available permeable area for stormwater infiltration and exposes infrastructure to corrosive saltwater. Disposal of fresh stormwater into saltwater lenses and wedges via injection wells is a widely applied strategy that has not been adequately studied before; exploratory simulations are being conducted. While the corrosive effects on metallic pipes and above-ground reinforced concrete

are well known, the impacts of saltwater interfaces and tidal fluctuations in the subsurface on foundations passing through zones of varying salinity have not been broadly investigated. The 2021 collapse of the Surfside tower and the observed sinking of numerous high-rise buildings in Southeast Florida demand a fuller understanding of subsurface conditions and processes. A near-shore coastal subsurface monitoring system is being implemented in Southeast Florida and coastal hydrogeology is poised to play a prominent role in future adaptation in low-lying coastal areas worldwide.

Biography

Michael Sukop is professor of hydrogeology in the Department of Earth and Environment and the Institute of Environment at Florida International University in Miami, where he has taught and conducted research since 2003. He is a Fellow of the Geological Society of America, a licensed professional geologist, and a certified hydrogeologist in California. He was selected as the 2026 Birdsall-Dreiss/LaMoreaux distinguished lecturer by the Geological Society of America's Hydrogeology Division. He principally works on groundwater issues in Southeast Florida, including saltwater intrusion, septic systems, injection wells, and groundwater inundation. He has expertise in groundwater and solute transport modeling, especially as they apply to seawater intrusion and the physics of the Biscayne Aquifer. He co-authored Version 4 of the popular SEAWAT model for seawater intrusion. He is the author of two books on Lattice Boltzmann computational fluid dynamics modeling. His team is currently implementing the coastal subsurface monitoring network for Southeast Florida (<https://coastal-subsurface.fiu.edu/>).

Presentation Abstracts

Wednesday, October 7

10:40 am - 12:00 pm

Hydrology

Remediating Groundwater in a Karst Terrane – Encouraging Results and Lessons Learned

Urvi Tulsiani, Jason M. Tillotson, Allison Nelan, Keith A. White

Karst aquifers, characterized by a combination of multiple porosity types, discrete flow paths, and variable hydraulic conductivities, create a highly complex and heterogeneous environment that influences both the storage capacity and transport of contaminants in the subsurface. These complexities of karst aquifers present unique challenges for remediating contaminated groundwater. Pilot studies were performed at eight sites at Redstone Arsenal (RSA) in Huntsville, Alabama, to assess the viability of in situ injection-based remedies to treat groundwater impacted by chlorinated volatile organic compounds (CVOCs) and perchlorate in the epikarst, the uppermost, highly weathered rind of karst bedrock. The studies assessed effectiveness of two injection-based in situ remedial technologies: in situ bioremediation (ISB) and in situ biogeochemical reduction (ISBGR). The injected remedial amendment or “substrate” for ISB was emulsified vegetable oil and for ISBGR was a combination of organic carbon and zero-valent iron. ISB injections were performed in the epikarst using permanent injection wells screened across the contact between the overburden and underlying bedrock at each of the eight sites. At six of the eight sites, ISB or ISBGR injections were also performed in the overburden using temporary injection points to evaluate the impact of overburden injections on the treatment of epikarst groundwater. Pilot study areas were co-located in the overburden and epikarst at three of these six sites. Fluorescent dyes were added to the substrate at two sites to evaluate substrate distribution and define the performance monitoring network. Post-injection monitoring confirmed successful substrate delivery, establishment of strongly reducing conditions, and significant declines in CVOCs and perchlorate at several locations, demonstrating that in situ injection-based remedies can be implemented effectively in karst settings. Lessons learned from these pilot studies inform the potential for full-scale remedial implementation and underscore the importance of adaptive injection strategies, robust performance monitoring, and the use of tracers to address site-specific heterogeneity.

A Simple Approach to Assessing Groundwater Discharge Behavior at Government Spring, Central New Mexico

Matthew Kaspar, Benjamin Tobin, Margaret Furtner

Government Spring is the perennial source of the lower Rio Bonito in central New Mexico with numerous ephemeral sources and a complex surface water – groundwater interface. Discharge from this karst spring is critical in maintaining downstream agricultural activities and communities. As part of a larger study to document the groundwater basin of this spring, this study focuses on simple repeated measurements to assess the surface water – groundwater interactions along the spring run. We established 11 repeatable measurement sites for discharge, temperature, pH, and specific conductivity. Data collected at a monthly interval provides a snapshot of surface water – groundwater interactions in the system. This simple repeatable approach allows for a base understanding of how system interactions vary across flow regimes. Our results indicate that the spring is fed by two distinct sources: a more variable flow component with relatively high pH and low conductivity and temperature, and another with more constant flow, more neutral pH, and higher temperature and conductivity. These two sources are each isolated to two distinct channels and combine partway through the spring run. These data suggest that the more stable discharge source is likely driven by the karst aquifer, while the more variable source may be shallow flow through an overlying alluvial aquifer fed by the upstream ephemeral sections of Rio Bonito. Moving further downstream along the spring run, additional discharge increases the flow of Rio Bonito. Data collected suggests that this is likely a result of additional alluvial storage discharging to the river. While this study uses simple field water quality and quantity data, our work shows the utility of repeated temporal and spatial sampling in quantifying spring discharge dynamics.

Ongoing Dye Tracing Prompts Major Reevaluation of Groundwater Divides for the Lost River Karst System, Bowling Green, KY, USA

Lee Anne Bledsoe, Chris Groves, Nick Lawhon

The Lost River Groundwater Basin located in south-central Kentucky may be one of the most thoroughly investigated karst basins in the US. Over the past 50 years, numerous studies have been conducted primarily due to the environmental challenges created by urban development on a well-developed sinkhole plain. The City of Bowling Green (pop. ~80,000) covers much of the basin but lies primarily in the northern, downstream reach nearest the main outlet of the system, the Lost River Rise. However, land use in the southern, up-gradient, portion of the basin is quickly changing from undeveloped and/or agriculture to industrial and residential.

Due to local concerns of how large-scale residential development and the increase of impermeable surfaces could affect flooding in

adjacent areas, Crawford Hydrology Lab (CHL) partnered with landowners and regulators to better understand the localized hydrology near the community of Richpond. Considering the Lost River basin had been delineated using dye tracing, potentiometric surface mapping, detailed lithological studies, cave survey, and geophysical techniques, basin boundaries were assumed to be correct and detailed sub-basin dye traces were conducted. Phase I traces in 2021 were inconclusive as dye was not recovered at any monitoring location. Recognizing the data gap in the interpreted basin boundaries, CHL broadened the scope and conducted a multi-phase dye trace investigation, using multiple dyes over several years, to reevaluate the Lost River Groundwater Basin boundary. Dye tracer tests conducted by CHL in 2023-2026 have now conclusively shown that roughly nine square kilometers of recharge area once attributed to Lost River Rise is indeed part of the Cloud Spring Basin and we present a new basin boundary map. This study directly informs planning and zoning, storm water management, and hazard mitigation. Results also infer that the complex lithology is still not fully understood in this area of the basin and warrants additional study.

Stratigraphic Controls on Recharge to the Confined Aquifer of the North Coast Karst Belt of Puerto Rico

Brian A. Smith

The north coast karst belt of Puerto Rico is well known for its conical shaped, limestone hills (mogotes), the Río Camuy cave system, the Arecibo Observatory (now defunct) where a large reflecting antenna is situated in a large (but modified) sinkhole, and hundreds or thousands of other caves. The two main aquifers associated with the north coast karst belt of Puerto Rico provide water for industry, agriculture, municipalities, and domestic uses. Tertiary-age geologic formations associated with both aquifers consist largely of limestone. Significant karst features such as mogotes and sinkholes are common where these units are exposed at the surface.

The surface and subsurface geologic units within the north coast karst belt consist largely of Oligocene to Miocene-age sedimentary formations overlain by semi-consolidated to unconsolidated Quaternary deposits. The principal karst forming geologic units associated with the confined (lower) aquifer in the study area are the Oligocene-age Lares Limestone and the overlying Cibao Formation. The Lares sits conformably on the San Sebastián Formation which consists of sandy limestone and consolidated and unconsolidated sand. A marly unit in the upper section of the Cibao provides confinement between the confined and the unconfined (upper) aquifers. The unconfined aquifer consists of the Aguada and Aymamón Limestones. This study focuses on three sites where water recharges the confined aquifer: Cabachuelas Cave Preserve in the municipality of Morovis, the municipality of Vega Alta, and the municipality of Toa Alta.

This study shows that the outcrop area of the Lares and Cibao formations is a significant source of water to the confined aquifer to the north that is used extensively by industry, agriculture, and

municipalities. A better understanding of this water source could lead to better protections for water quality and could avoid the contamination by industrial activities of the unconfined aquifer.

Wednesday, October 7

2:00 pm - 3:00 pm

Northeastern Karst

Springs of the Catskill Mountains: A Conduit Flow System in Predominantly Siliciclastic Strata

Daniel H. Doctor, Joshua R. Benton, Martin A. Briggs, William E. Odom, Neil C. Terry

The Catskill Mountains of New York state are composed of thick sequences of interbedded mudstone, sandstone, and siltstone that are intercalated with thin beds of paludal limestone and calcareous mudstone. The rocks are interpreted to have been deposited on a broad coastal alluvial plain under a sub-humid environment in the Late Devonian. Sandstones often contain rip-up clasts of calcareous material at their bases and contain minor amounts of carbonate cement throughout their mass. This minor amount of calcareous material weathers out to produce thin, preferential flow zones of solutional porosity and permeability integrated within perched aquifers that feed perennial hillslope springs. Solutional features are evident within thin carbonate lenses and along fractures in sandstones, occasionally resulting in explorable cave-sized conduits at outcrops.

This study focuses on the behavior of bedrock springs and seeps in the headwaters of the Neversink River watershed above the Neversink Reservoir. Bedrock springs are numerous throughout the Catskill Mountains providing baseflow to headwater streams and downstream reservoirs that tends to be more persistent during dry times than other baseflow sources. We observed dissolution-influenced conduits within the bedrock, and suffosional conduits within unconsolidated materials. Continuous water temperature at six springs was monitored at hourly intervals from May to October 2022 to investigate the thermal response of groundwater to daily and seasonal changes in air temperature along with event-based meteorological events. Temperature monitoring was augmented at some springs with time-lapse photography to evaluate the relative persistence of flow. The thermal responses of springs to precipitation events were highly variable across sites, with some springs exhibiting flashy co-incident responses indicating a strong connection to the surface, while other springs showed muted or no thermal response to events, indicating longer residence time groundwater sources. The seasonal thermal response also varied across sites having lag times of 23-48 days between peak air temperature and peak spring water temperature. The water temperatures and geochemical compositions of these bedrock springs support a conceptual model of multiple residence times, showing both event and seasonal groundwater

storage within the conduit flow system that feeds the springs of the Catskill Mountains.

Karst at a Potential Construction Site Adjacent to the Delaware River Near the Glacial Terminus, New Jersey, USA

Ira D. Sasowsky

The state of New Jersey is not known for extensive karst landscapes, but there are over 100 caves listed in a survey of those features. Numerous sinkholes have also been identified, though no comprehensive database yet exists. Occasional news stories have reported damaging collapses, many of which seem infrastructure related, in several counties. This paper reports on the conditions at a proposed major construction site in a glaciated limestone terrane, Warren County. The area is underlain by the Allentown Dolomite and the Beekmantown Group carbonates (Cambrian/Ordovician age) and covered with a variable layer of glaciofluvial sediments. The area is of extra concern for karst-related issues because:

- 1) It is close to the terminal margin of multiple glacial advances and therefore was likely subjected to high surface and groundwater flux of waters undersaturated with respect to CaCO_3 .
- 2) It is close to the incised Delaware River, which is ~50 m (160 ft) lower in elevation, implying valley wall stresses and increased local hydraulic gradients that could increase the development of karst features.
- 3) An abandoned, possibly pre-glacial, streamway crosses the site.
- 4) A thrust fault bounds the area on the east, across which lie low solubility crystalline rocks forming an alloctenic highland. Anticipated site changes included large impermeable areas, stormwater management, groundwater extraction, and wastewater disposal.

Concerns included infrastructure stability, water quality and water availability. Although surface expression of karst features was minimal, preliminary excavations and limited well data indicated an irregular rockhead and deep high permeability zones. In the end, this project was withdrawn, though not due to karst conditions. A wholistic approach combining regional geologic history, hydrogeology, site observations, subsurface data, and planned development impacts provides benefit when evaluating karst risk.

Karst Sinkholes and Civil Engineering: Overview of Characterization and Treatment Options from a Geophysical and Geotechnical Viewpoint

Mia Painter, Stephen Welsh

Sinkholes pose a significant geohazard to civil engineering

infrastructure in regions underlain by carbonate karst terrain. Selecting an appropriate stabilization method requires balancing site conditions, infrastructure risk, environmental considerations, and cost, all of which depend on a thorough understanding of the planned or existing infrastructure and subsurface conditions. This paper provides an overview of common sinkhole characterization and stabilization methods used in the Mid-Atlantic and Appalachian regions of the United States from both geotechnical and geophysical perspectives. The application of geophysical methods in conjunction with intrusive investigations is reviewed as a means of reducing subsurface uncertainty and refining treatment designs. Geotechnical treatment options, including excavation and reverse-grade filters, grouting, deep foundations, and bridging structures, are discussed along with the factors influencing treatment selection. Two example projects involving infrastructure impacted by sinkholes demonstrate how integrated geophysical and geotechnical investigations guided stabilization efforts, improved understanding of subsurface conditions, and supported cost-effective engineering solutions. The examples illustrate the value of combining complementary investigation methods to reduce uncertainty and develop stabilization approaches appropriate for site-specific conditions.

Wednesday, October 7 3:20 pm - 5:00 pm Geomorphology

A Comprehensive Analysis of Stratigraphic Influence on Karst Feature Distribution and Density Across Southeast Minnesota, USA

Julia R. Steenberg, John D. Barry, Andrew J. Retzler, Anthony C. Runkel, Robert G. Tipping, E. Calvin Alexander, Jr.

Karst features pose significant risks to infrastructure and land use, from reducing tillable acreage to causing catastrophic failures in wastewater lagoons. This study analyzes the stratigraphic and spatial distribution of karst features in southeastern Minnesota to better understand their geologic controls. By seamlessly merging raster surfaces of Paleozoic bedrock units and intersecting them with regional karst datasets in a GIS framework, we found that over 95% of mapped sinkholes occur where unconsolidated sediment overlying bedrock is 15 m or less. Furthermore, 81% of sinkholes are concentrated in just 6 of the 21 mappable bedrock units, each of which is carbonate-dominated. Sinkhole densities calculated independent of stratigraphic context vary spatially, locally exceeding 40 features per square kilometer. In contrast, springs show a broader stratigraphic range with 51% occurring within four specific units. Increased spring frequency correlates with zones where gravity-driven vertical groundwater flow through fractured carbonate encounters low-vertical but high-horizontal hydraulic conductivity intervals—underscoring a highly anisotropic flow system. In deeply incised valleys

characterized by artesian conditions, spring frequencies increase in units subcropping along aquitard edges. This comprehensive stratigraphic analysis enhances our understanding of geologic controls on karstification, providing a tool for better land and water resource management decisions in southeast Minnesota.

Hasparos Embayment – An Example of Intrastratal Hypogenic Speleogenesis

Peter J. Hutchinson

The Hasparos Embayment contains Neogene-aged deposits that overlie the Permian-aged San Andres Formation. The Hasparos Embayment consists of thousands of subsidence sinkholes, concentrated in two tracts covered with deposits provisionally considered to be part of the Ogallala Formation. The two Ogallala-covered karst fields are divided north and south by the Hasparos Canyon. The northern karst field includes 12,400 hectares, whereas the southern tract includes 6,900 hectares.

Intrastratal karst is a form of hypogene speleogenesis, in which karst develops in rocks buried by younger deposits after deposition of the younger rocks. Thus, during the temperate, late Pleistocene epoch, Lake Estancia, northwest of the Hasparos Embayment, discharged to the east-southeast and recharged groundwater in the Yeso (gypsum) and San Andres Formation (limestone). The groundwater migrated through a saddle in the Lincoln County Porphyry Belt deposits into the Hasparos Embayment gypsum/limestone deposits of the Yeso and San Andres Formations. Dissolution of the carbonates created intrastratal-type karst topography within the overlying, much younger Ogallala sediments.

Contrasting the Groundwater Pathways Driving Cave Formation in the Water Sinks Area in Highland County, Virginia, USA Using Electrical Resistivity Imaging

Shamsuddin Ahmed, R Shane McGary

Speleogenesis in carbonate bedrock occurs when water, acidified by CO₂, dissolves calcium carbonate (CaCO₃) in rocks to form voids and dissolutional conduits. The near surface geology of the Water Sinks area, Virginia, is dominated by Silurian–Devonian limestones, accommodating numerous karst features including sinkholes, caves, and springs. Groundwater flow and cave development in the area is thought to be guided primarily by geologic structure (folds, bedding, and joints) and low-permeability layers. In this study, we used electrical resistivity methods to detect and characterize conduits and water flow paths in the subsurface. We collected dipole-dipole and Schlumberger array data along seven transects at various locations throughout the study area using a multielectrode geoelectrical imaging setup. We then computed inverted resistivity models for the subsurface (from dipole-dipole, Schlumberger, and merged datasets) with varying smoothness and noise thresholds using

a 2D inversion modeling software. The inverted resistivity sections confirm known void spaces (as indicated by very high electrical resistivity) near major caves in the area, while also revealing previously unknown void spaces, including evidence of a previously unknown maze cave complex. We interpreted the resistivity sections within the framework of the local geology to enhance the existing narrative of the speleogenetic history and karst hydrogeology of the Water Sinks study area, with future studies and expeditions focusing on the newfound cave system.

Brine-Enhanced Hypogenic Speleogenesis and Concentrated Karst Development in the Burton Flats, Eddy County, New Mexico

David D. Decker, Garrett Jorgensen Olague, Michael Jones, Ryan Palmer

The Burton Flats, a 259-km² gypsum-dominated outcrop of the Permian Rustler Formation 26 km northeast of Carlsbad, New Mexico, contains more than 3,500 documented karst features — an anomalously high density relative to surrounding areas of equivalent lithology. The proposed explanation is a two-step brine-enhanced dissolution mechanism driven by the spatial intersection of three factors: the eastward-dipping Rustler Formation outcrop, the underlying Capitan Aquifer, and the intervening Permian Salado Formation. Fresh Capitan water dissolves Salado halite, generating an NaCl-enriched brine up to three times more aggressive toward gypsum dissolution than freshwater; this brine ascends into the Rustler Formation along the Capitan flowpath, driving hypogenic cave and karst development at anomalously high rates. As surface denudation progressively exposes the Rustler Formation eastward, the karst hazard zone is expanding into previously unrecognized areas with significant implications for infrastructure planning in the northern Delaware Basin. Geophysical characterization methods are addressed in an upcoming paper.

Thursday, October 8 9:00 am - 10:00 am Sinkhole Mapping

Statewide Sinkhole Susceptibility Mapping in Florida Using Explainable GeoAI

Osama M. Al-Tarawneh, Weiwei Zhan, Clint Kromhout

Sinkholes cause persistent damage to infrastructure, property, and groundwater resources across Florida. Statewide sinkhole hazard mitigation has been constrained by incomplete inventories and the absence of a high-resolution susceptibility map. This study presents a statewide sinkhole susceptibility assessment using an explainable GeoAI framework that integrates the citizen-reported Subsidence Incident Reports (SIR) database and a geologist-

confirmed collapse-type sinkhole inventory from the Florida Geological Survey (FGS). Random Forest (RF) is used as the primary learner with ten geologic, hydrologic, topographic, and anthropogenic predictors. The influence of negative-sample buffer geometry on model behavior is evaluated across five annular buffer conditions (100-1000 m through 1000-10000 m). Two Explainable Artificial Intelligence (XAI) methods, Gini-based feature importance, and accumulated local effects (ALE), identify dominant controls and nonlinear predictor responses. The statewide model achieved receiver operating characteristic area under the curve (ROC-AUC) of 0.859 under the selected 500-5000 m buffer. Land use/land cover (LULC), overburden thickness, and distance to karst features are the leading predictors, and their nonlinear thresholds align with well-established karst dissolution and collapse processes.

Comparing Manual and Automated Methods in Sinkhole Delineation: A Cantabrian Mountains (Spain) and Tasman Mountains (New Zealand) Case Study

Mario Puente-Sierra, Javier Santos-González, Rosa B. González-Gutiérrez

Studies of karst landforms, such as sinkholes, have advanced in recent years due to technological advances and the rise of automated detection methods. Such methods offer notable time-saving strengths, but their limitations in complex terrains are frequently overlooked in modern literature. To compare these automated methods to traditional manual methods, we selected four karst massifs in the Cantabrian Mountains (Spain) and two in the Tasman Mountains (New Zealand) as study areas. High-resolution LiDAR-derived Digital Elevation Models were used to identify and map sinkholes. Automated detection was performed using a Geographic Information System and included: i) a depression-filling method; ii) a sky-view factor method; and iii) different deep learning models trained with manually mapped sinkhole data and a leave-one-region-out approach. The manual method used photointerpretation to draw the curvature of a sinkhole and field validation confirmed this method correctly identified 97.8% of sinkholes. Results in sinkhole detection and delineation varied substantially between methods. Deep learning models—HRNet in particular—outperformed other methods, achieving a mean F1 score of 0.74 and an Intersection over Union of 0.59, capturing 63.9% of sinkholes with minimal morphometric distortion. Furthermore, performance was unequally distributed, declining sharply in areas with steep or forested terrain. These discrepancies highlight the influence of local characteristics on the performance of automated methods. Their widespread adoption and their perception as a gold standard have led to a decrease in the use of traditional methods, occasionally at the risk of compromising accuracy and scientific rigor.

Attention-Enhanced Multimodal Fusion of Elevation and Aerial Imagery for Sinkhole Segmentation

Junfeng Zhu, Desireé Cunningham, Nathan Jacobs

Image segmentation, the task of assigning a class label to each pixel in an image, has been widely applied in remote sensing to identify surficial geological and hydrological features from data sources such as multispectral satellite imagery, aerial photography, and digital elevation models. UNet is among the most widely adopted convolutional neural network architectures for segmentation, owing to its encoder–decoder structure and skip connections that enable precise spatial localization. UNet has been applied to detect sinkholes using lidar-derived high-resolution digital elevation data; however, existing models still fall short of the accuracy of manual sinkhole mapping. In this study, we aim to improve UNet-based sinkhole segmentation by incorporating attention mechanisms and fusing elevation data with aerial imagery. Attention mechanisms allow the model to learn to focus on the most task-relevant parts of the input, selectively emphasizing features and spatial regions indicative of sinkholes. Aerial imagery provides complementary visual cues, such as vegetation changes near or within sinkholes, that are routinely leveraged in manual mapping, and fusing it with elevation data may help distinguish sinkholes from similar topographic features. We trained and evaluated our models using high-resolution lidar-derived elevation data, plane-based leaf-off aerial imagery, and high-accuracy manually mapped sinkhole inventories from multiple areas in Kentucky. We compared the performance of UNet and an attention-enhanced UNet, referred to as UNet-T, across different combinations of input modalities. Our results suggest that model generalization improves with an increasing number of training areas, and the combination of DEM gradients and topographic derivatives (slope, aspect, and curvature) yields the strongest terrain representation. In addition, fusion of aerial imagery with DEM inputs can enhance model performance. Conversely, UNet-T provides only a marginal and inconsistent advantage over UNet.

Thursday, October 8 10:20 am - 11:40 am Geospatial

Cover Collapse Sinkholes in Stormwater Infrastructure in the Urban Karst of Bowling Green, Kentucky – Occurrence, Mitigation, and Prevention

Nick Lawhon

Cover collapse sinkholes are an extremely common geohazard in karst terrains. These features, formed by concentrated flows of water entering the subsurface through discrete points in the epikarst, are particularly common in stormwater infrastructure in

Bowling Green, KY. There are currently 787 known stormwater basins and hundreds of miles of stormwater conveyances in this fast-developing city, all of which concentrate stormwater flows over the naturally sinkhole-prone karst system. This paper reports on the occurrence of cover collapse sinkholes in stormwater infrastructure, particularly retention and detention basins, from inspections over the past 7 years and records from City-managed sinkhole repair projects, and inspections in 2026 of an additional 119 public and private stormwater basins in the City specifically to document the occurrence of cover collapse sinkholes. Sinkhole occurrence is analyzed with respect to basin type and the presence of permanent stormwater quality systems installed for compliance with local and state regulation. Stormwater injection wells are the most common point of initiation for sinkholes in Bowling Green based on the reviewed records. Results indicate that sinkhole formation in a basin is dependent on the type of basin, with those drained by stormwater injection wells being much more likely to have a sinkhole. Basins with water quality measures have a higher rate of sinkhole occurrence, and as such appear to be inappropriate in Bowling Green due to the prevalence of sinkholes in basins of this type.

A Comprehensive Look at Ohio's Karst Inventory Mapping Reconnaissance, Ground-Truth, and Beyond

Brittany Parrick, Douglas Aden

The present iteration of the karst inventory mapping program at the Ohio Department of Natural Resources, Division of Geological Survey (herein the Survey) has been ongoing since 2009. With documentation of the Survey's previous karst inventory mapping scattered across several decades-old publications—coupled with the karst community's demonstrated need for a standardized database—this paper outlines the program's evolution from its inception to the present.

New Digital Elevation Models (DEM) derived from modern Light Detection and Ranging (LiDAR) datasets, along with modern mobile applications, have significantly improved remote sinkhole detection and streamlined field verification. The Survey has developed a model to derive depression polygons from DEM rasters and established a workflow to assess their likelihood of being karst. We use standardized, in-person methods to verify karst features in the field. This synthesis of modern geospatial tools and field-based methods has resulted in a two-year plan to modernize Pavey et al.'s 1999a statewide map, Known and probable karst in Ohio, and the statewide database.

Building this catalog of over 32,000 karst features (which includes primarily sinkholes, as well as all known springs, caves, and disappearing streams) supports more comprehensive research, including regional comparisons, tracking of feature evolution across time, and improving accuracy of related foundational geologic datasets (e.g., bedrock topography). As the karst feature inventory has grown, collaboration with other states' karst mappers has focused on managing database structure.

Others may adapt these methods to their own karst-mapping needs and join the Survey in contributing towards a standardized national karst database.

Characterization of the Galena Karst of East-Central Olmstead County Minnesota

John D. Barry, Ronald C. Spong, Peter J. Hutchinson, Martin R. Larsen, Anthony C. Runkel

The Galena Group is mostly composed of carbonate rock with subordinate beds of fine siliciclastics, mainly shale. In southeastern Minnesota, it is a source of water for domestic and agricultural use.

Hydrologic and geochemical characterization of a Galena Group spring, Bear Spring, began in 1979. Recent springshed delineation through dye tracing and continuous level, temperature, and nitrate monitoring has shed light on the aquifer's hydrologic response to precipitation, but the degree of karstification in the Galena was unclear. Current and planned future modeling require additional insight into the pervasiveness of fractures and conduits, and their properties.

A suite of characterization approaches, including karst mapping, lineament delineation, 2-D Electrical Resistivity Imaging (ERI), and quarry observations were used to provide an enhanced 3-D view of the Galena Karst. Sinkhole and cave mapping determined that the conduits are bell-shaped and range from approximately 0.5 to 3.5 meters wide to 0.8 meters high. Two-dimensional ERI revealed distinct differences in resistivity signals consistent with clayey overburden, unsaturated karst, and saturated carbonate rock. Drought conditions allowed characterization of the karst fabric using a previously reported technique, crop line delineation. Relatively healthy green-hued vegetation growing in gaps was distinctly different than adjacent crops, allowing for GIS analysis of fracture line trends. Trends are dominated by northeast/southwest and northwest/southeast orientations. Observations from a quarry 2.6 kilometers north provide further context into the depth dimension and pervasiveness of fracturing, with centimeter to decimeter apertures penetrating a minimum distance of 7.3 meters from the bedrock surface to the quarry floor.

This characterization of karst in the Bear Spring vicinity better constrains fracture orientations, penetration depths, and conduit size and shape to use in future modeling of the aquifer.

Investigating Sediment Accumulation Dynamics via Integration of GIS and Remote Sensing Tools Along with Physical/Chemical Characteristics of Sediments in Owl Cave, Highland County, Virginia

Dhanuska B. Wijesinghe, Spencer Schmidt

The Valley region of Virginia, USA, features cave and karst systems. Variation in surface topography and vegetation within these systems significantly affects sediment accumulation in cave

ecosystems. Remote sensing and GIS tools effectively analyze surface conditions, including vegetation cover and its influence on sediment buildup in caves. This study involved collecting high-resolution drone imagery, such as LiDAR, multispectral, and thermal data near Owl Cave in Highland County, VA, to understand the sediment accumulation process inside the cave system. High-resolution digital elevation models (DEMs) were created from LiDAR point clouds, and vegetation indices like Normalized Difference Vegetation Index (NDVI) were calculated using multispectral data. Additionally, the sediment transport index (STI) and topographic position index (TPI) were computed from elevation models to evaluate how surface vegetation impacts erosion and sediment transport. Sediments were characterized physically and chemically by collecting two cores: one from inside the cave and one from the entrance at different depths, analyzing particle size via laser diffraction and organic carbon content through loss on ignition methods. A pooled T-test compared variability in particle size and organic carbon among the cores. Results indicated that samples from inside the cave contained significantly more sand, while silt was higher at the entrance; clay content differences were not significant. Organic carbon inside the cave was below 5%, whereas at the entrance, it ranged from about 7% at the surface to below 5% at deeper depths. The weak correlation between NDVI and STI suggests that topography influences sediment deposition more than vegetation, a pattern common in karst terrains. Lower TPI values (mean = -2.19) reflect higher depositional zones around the cave. Variations in particle-size distribution inside and outside the cave are due to sediment influx during high-flow events and weathering of the cave walls.

Poster Abstracts

Thursday, October 8

4:00 pm - 7:00 pm

Production Variability in the Edwards Aquifer, South-Central Texas, USA

Jennifer R. (Adkins) Schudrowitz, Linda K. Bevis

The San Antonio Water System (SAWS) serves more than two million people and is among the largest water utilities in the United States. Much of SAWS's supply is sourced from the Edwards (Balcones Fault Zone) Aquifer (Edwards BFZA), a major sole-source karst aquifer in south-central Texas. The aquifer exhibits pronounced spatial heterogeneity in well performance due to its karstic nature, structurally complex setting, and variable depositional facies. Recent severe drought and pumping restrictions have emphasized the need to understand where within the aquifer to drill and how inter-station performance differs under stress.

This study evaluates production variability across SAWS

pump-station wells completed in the artesian zone and intersecting distinct members of the Edwards Group. We relate well-scale performance, characterized primarily by specific capacity and drawdown data, to member-scale heterogeneity and structural setting using station records, aquifer-test data, and published interpretations of fracture-dominated flow at the well scale and conduit influence at regional scales. Inter-station variability reflects how wells with similar construction and operating conditions can differ markedly in production, an effect that becomes increasingly important as climate-related stressors intensify pressure on groundwater supplies.

Observations indicate that production differences among stations reflect both local hydrogeologic variability and broader geologic controls, including depositional changes and structural boundaries. These differences highlight how documented hydrogeologic heterogeneity within the Edwards BFZA is expressed through variability in well performance across SAWS production system.

Engineering implications include improved well-site selection and completion strategies, and integration of aquifer-test data with geologic interpretation to better characterize well and station performance. SAWS operates an extensive, hydraulically interconnected pressure-zone system, and production variability at the wellfield scale translates directly to system-wide considerations, including pressure management, zone balancing, and drought-stage operations. These findings inform utility-scale decisions related to drilling, testing, and operational planning .

A Field-Inspired Investigation of Conduit Network Impacts on Spring Flow in Karst Aquifers

Jenny Huang, Jannes Kordilla, Marco Dentz, John Barry, Christian Langevin, Peter Kang

Effective management of karst aquifers necessitates accurate characterization of flow and transport. However, modeling these highly heterogeneous systems is challenging due to the complex partitioning of recharge between bedrock and the embedded conduit network. The properties of conduit networks impact flow and transport, but there has not been a systematic, quantitative study of how conduit network structure and geometry impact spring hydrographs in naturalistic field conditions. In this field-inspired modeling study, we attempt to identify key geometric and structural properties of conduit networks that control flow in karst aquifers and use these insights to constrain our understanding of a nitrate and chloride-impacted karst aquifer in Southeastern Minnesota.

We systematically vary network structure for a field-inspired conduit network and model spring flow with the model openKARST coupled with a linear reservoir model. We identify network complexity and slope as two key factors that impact the spring hydrograph by delaying peak arrival. However, no significant peak dispersion or attenuation was observed in any of the networks, evidenced by the lack of difference in recession coefficients between network structures. This introductory study

demonstrates the quantifiable impact of conduit network structure on spring hydrograph behavior and provides some contexts in which spring flow is predominantly controlled by infiltration and matrix processes, resulting in minimal influence of the conduit network structure.

Sinkhole Hazards, Risks and Remediation: A Fifty-Year Case Study in New Jersey, USA

Oladayin Kolawole, Rita L. Sousa, Christina Comuso, Mohab Hussein

New Jersey presents a uniquely complex sinkhole and ground subsidence hazard shaped by intersecting geological, industrial, and anthropogenic forces. Sinkhole herein refers primarily to collapse sinkholes, that is, the abrupt or progressive downward failure of the ground surface into subsurface voids, as distinct from solutional closed depressions of purely karst origin. This paper synthesizes five decades (1976–2026) of documented sinkhole and ground subsidence records across the state, examining root causes, societal and environmental impacts, and remediation strategies employed in response to such hazards. The review shows that New Jersey's hazard is governed by three dominant mechanisms: karst dissolution in carbonate rocks of the northwestern counties; collapse of legacy mines; and utility-related subsidence in urbanized areas. Recent events, including the 2024–2025 I-80 Wharton mine-subsidence crisis and the 2026 Phillipsburg karst sinkhole emergency, demonstrate how localized subsurface voids can cause regional transportation disruptions, residential displacement, and substantial public repair costs. Common remediation responses include void grouting, compaction grouting, targeted geophysical investigation, borehole verification, utility repair, and post-remediation monitoring. The study identifies persistent gaps in New Jersey's sinkhole-risk management framework, including incomplete mine records, fragmented incident reporting, limited public sinkhole databases, and uneven insurance coverage. The findings support a transition from reactive repair toward integrated hazard mapping, legacy data recovery, condition monitoring, and risk-informed land-use and infrastructure planning.

Mobile LiDAR Scans of Caves; Methods for Tying in Ground Control Points

Robert Salaz, Jacob Slyder, Ellen Trautner, Georgia Schneider

Mapping cave passages using modern techniques such as Light Detection and Ranging (LiDAR) and photogrammetry are still in the juvenile stages. Newer technologies such as Simultaneous Localization and Mapping (SLAM) LiDAR and faster computers have enabled speleologists to map caves much faster than traditional methods. From a land management perspective, the ability to efficiently collect detailed cave maps with reasonable precision quickly is crucial for decision making. The ongoing challenge with digital cave mapping using mobile LiDAR and photogrammetry techniques is geolocating the point-cloud underground.

Mobile scanning methods can be tied to ground control points on the surface using high precision Global Navigation Satellite System (GNSS) receivers. By starting scans at the surface, entering, and then exiting the cave, the control points at the surface allow the SLAM algorithm to locate voids in space. This method only works so far, roughly 20 to 30 minutes, before the SLAM algorithm and Inertial Measurement Unit (IMU) start to iteratively collect errors and wander. Within GNSS denied environments, other methods must be employed to geolocate LiDAR data deeper into cave passages. Traditional cave surveying methods are geolocated by successively surveying and tying underground points to a control point near the cave entrance. We propose to marry digital cave mapping techniques with more traditional methods. Together, modern and traditional cave survey methods can tie in control points within caves to quickly produce geolocated cave maps within a Geographic Information System (GIS) because extensive measurements and sketches are not needed at each station. A visual comparison of point-cloud data to a line plot from a traditional survey confirms that the combination of these methods can efficiently produce geolocated cave maps, however the accuracy of these data is not well established. We propose that this technique can then be used by land management agencies to quickly gather cave data that will inform decisions about land use and placement of infrastructure.

Mapping Sinkholes and Closed Depressions in the Edwards Aquifer Recharge Zone: Comparison of LiDAR-Based Semi-Automated Detection Methods and Field Validation

Enzo Franceschi Genesi, Horia G. Olariu, Bradford Wilcox

Sinkholes and closed depressions play a critical role in karst hydrology by facilitating rapid recharge to aquifer systems, yet their spatial distribution is often poorly quantified in large recharge zones, and the automated methods used to detect them vary widely in approach and reliability.

This study compares three LiDAR-based automated detection methods to determine their relative performance for mapping sinkholes and closed depressions within the Edwards Aquifer Recharge Zone, using a 0.5-meter resolution bare-earth Digital Elevation Model derived from high-density airborne LiDAR point cloud data (12.66 points/m²) obtained from OpenTopography. The three methods evaluated were a Hydrological Depression Extraction approach based on sink-filling and fill-difference raster analysis with morphometric filtering by circularity, area, and depth; a Local Depression Index analysis using a Topographic Position Index-based raster to identify relative topographic lows; and a Contour-Based Closed Depression approach employing automated sinuosity analysis to identify geometrically closed contours. The methods yielded 22, 83, and 444 candidates respectively, with no spatial overlap between the two raster-based methods, reflecting fundamental differences in input data preprocessing and detection algorithms. Field verification of 86 candidates showed that the Hydrological

Depression Extraction method achieved the highest reliability (100% field confirmation), while the Local Depression Index method detected a broader but noisier population of subtle features (86.4% confirmation). The Contour-Based method independently confirmed all Hydrological Depression Extraction detections, serving as an effective geometric cross-validation framework. These results indicate that the Hydrological Depression Extraction method is best suited for high-confidence detection of well-defined depressions, whereas the Local Depression Index method offers greater sensitivity at the cost of precision. The multi-method comparative framework presented here establishes a validated basis for selecting and scaling automated depression detection across the broader Edwards Aquifer recharge zone.

Biogeomechanics of EICP Reinforcement of Karstified Rock Masses

Mary C. Ngoma, Oladoyin Kolawole

Sinkholes are among the most significant karst-related hazards, arising from the dissolution of soluble rock and subsequent collapse of overlying geomaterials, thereby compromising rock mass stability and underground infrastructure. Conventional sinkhole remediation approaches often rely on cement-based grouting to prevent failure; however, the associated environmental impacts underscore the need for eco-friendly and sustainable alternatives such as biocementation. While biocementation has been a widely applied technique in reinforcing soils and cemented structures, the potential of biocemented hybrid soil-embedded karstified rock systems remains unexplored. To address sinkhole-related post-hazard remediation, this work investigates the potential of biocementation as a sustainable reinforcement strategy for sinkhole-susceptible rock masses, involving granular infill of subsurface cavities followed by enzyme-induced calcite precipitation (EICP). Limestone-based hybrid rock specimens will be designed, containing sand-filled cavities treated with EICP, and subsequently, the specimens will be subjected to uniaxial compression tests to characterize their mechanical response and Micro-computed tomography (μ -CT) scans for microstructural evolution. Results show that EICP-biocementation increased the unconfined compressive strength (UCS) of the specimens with cavity reinforcement by up to 57%, while μ -CT analysis revealed significant occlusion of limestone microporosity in treated specimens. These findings demonstrate the potential of biocementation in the repair of sinkhole-susceptible rocks with cavities by transforming dissolution-induced cavities into coherent, load-bearing zones, offering a sustainable biogeotechnical approach for stabilizing sinkhole-prone strata and protecting subsurface infrastructure.

Creating a Karst Features Map of a 7.5-Minute Quadrangle in Northern New Jersey

Zachary C. Schagrin

Extensive areas of northern New Jersey are underlain by carbonate rocks, ranging from Proterozoic marbles to Paleozoic limestones and dolomites. These areas include large portions of Sussex and Warren Counties, as well as smaller areas within Hunterdon, Morris, Passaic, and Somerset Counties. As part of its efforts to map the geology of the state, the New Jersey Geological and Water Survey (NJGWS) has undertaken efforts to create karst features maps of quadrangles within this area—known as the Karst Susceptibility Project Area. Through field mapping, GIS analysis, and interpretation of past data collection, NJGWS began publishing these 1:24,000-scale maps in 2023. These karst features maps utilize techniques for the automated delineation of sinkholes and closed depressions, as well as custom GIS toolboxes to assist with the identification of karst features. This is especially helpful in New Jersey, which hosts a covered karst terrain and where karst features display a muted expression and can be difficult to identify under surficial cover. The maps show the distribution of karst features by geologic formation and soil series type, as well as by thickness of surficial materials. They also include a discussion of factors impacting karstification in the map area. These include the thickness of surficial deposits, the extent of the various glaciations in New Jersey, and the location of ridges underlain by gneiss, granite, and shale adjacent to valleys underlain by carbonate rocks.



A cave in Schoharie County. Photo courtesy of Art Palmer.

Karst Clips

The Sinkhole Conference offers a special session called “Karst Clips” that allows participants to give a brief presentation about their work. This session, styled in the manner of “lightning talks,” is designed to broaden participation and content, as well as to provoke discussions among participants.

	Author	Title
1	Calvin Alexander	Horizontal Drilling Induced Sinkhole Collapse in a Non Karst Terrain
2	John Barry	Dual-porosity Hydrologic and Nitrate Monitoring in a Karstic Vadose Zone
3	Evan Choquette	Mapping Karst Features for Natural Resources Management on the George Washington and Jefferson National Forest
4	Michael Cobb	Creating Permanent Winter: Airflow Controls to Mitigate TCE in a Show Cave
5	Matt Dettman	Comparing Electrical Resistivity and Time Domain Electromagnetics for Sinkhole Investigations
6	Yongli Gao	Cascading Cover-Collapse Sinkholes in Unicoi County, Tennessee: Implications for Subsurface Instability and Hazard Delineation in Covered Karst Terrains
7	Yongli Gao	Reactivation of Swallets and Sinkholes Along Cibolo Creek: Renewed Recharge to the Edwards–Trinity Aquifer System in Central Texas
8	Vanessa Glaser	When Mining Meets Karst - Structural Controls on Subsidence in Western Pennsylvania
9	Peter Hutchinson	Western Ireland Karst
10	Clint Kromhout	3D Cave Mapping Using an Autonomous Underwater Vehicle - The Wakulla Basin GIS Mapping Project.
11	Nick Lawhon	KG-STORM: A Multi-Agency Collaborative Approach to Karst Groundwater Monitoring Flood Risk Assessment in Warren County, KY.
12	Mario Puente-Sierra	Sinkholes in Marble (New Zealand) and Limestone (Spain) Seen from Above
13	Johnny Vastag	A Case Study of Landfill Subgrade Arching
14	Keith White	Dye Tracing in the Upper Cambrian Briarcliff Formation, Orange County, NY
15	Dhanuska Bandara Wijesinghe	A UAV Remote Sensing and Geophysics Program for Karst and Environmental Research
16	Junfeng Zhu	A Glimpse of Data Captured by the Kentucky Sinkhole Reporting Form



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