The 13th Sinkhole Conference
Program with Abstracts
May 6-10, 2013
Carlsbad, New Mexico, USA
Table of Contents

Welcome Letter .................................................................................................................................................. 3

History of Conference ....................................................................................................................................... 4

In Memory of Dr. Barry F. Beck ......................................................................................................................... 7

Beck Scholarship ............................................................................................................................................... 9

Beck Scholarship Recipient ............................................................................................................................... 10

Organizing Committee ...................................................................................................................................... 11

Host City, Carlsbad, New Mexico ...................................................................................................................... 13

Conference Location, NCKRI Headquarters ..................................................................................................... 15

Field Trips ......................................................................................................................................................... 16

Short Courses ..................................................................................................................................................... 20

Program at-a-Glance ......................................................................................................................................... 23

Detailed Program ............................................................................................................................................... 24

Invited and Keynote Speakers .......................................................................................................................... 28

Presentation and Poster Abstracts ...................................................................................................................... 35

Barry Beck in a cave entrance on Mona Island, Puerto Rico (ca. 1976)
Official Program with Abstracts

The 13th Multidisciplinary Conference on Sinkholes and the Engineering & Environmental Impacts of Karst

“Integrating Science and Engineering to Solve Karst Problems”

May 6-10, 2013

Carlsbad, New Mexico, USA

Credits
Program with Abstracts prepared by Brian A. Smith and Brian B. Hunt, Barton Springs/Edwards Aquifer Conservation District, Austin, Texas.

Cover photograph by Lewis Land (NCKRI). Aerial view of Jim’s Water Service Sinkhole, northern Eddy County, New Mexico about six weeks after initial collapse.

Release
By submitting the registration form, you hereby release any photographs that may be incidentally taken of you during these events by SINKHOLE CONFERENCE 2013 to be used for any purpose.

Waiver
By registering, you agree and acknowledge that you are participating in the 13th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst (Sinkhole Conference 2013) and its activities intentionally and of your own free will, and you are fully aware that possible physical injury might occur to you as a result of your participation. You give this acknowledgement freely and knowingly that you are, as a result, able to participate in Sinkhole Conference 2013, and you hereby assume responsibility for your own well-being.

Recording of Presentations
The recording of any oral or poster presentation is prohibited without the prior approval of the author.
Welcome Karst Engineers and Scientists!

We are delighted to be your hosts for the 13th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst. For the past 29 years, this series of meetings has been among the most important in developing a better understanding of karst processes that result in environmental problems, and in creating effective measures that identify those problems before they occur, remediate them when they occur, and prevent them from occurring in the first place.

Since our last meeting in January 2011, this conference series has come under the management of the National Cave and Karst Research Institute (NCKRI). Shortly before his fatal illness, Sinkhole Conference founder Dr. Barry Beck contacted NCKRI about potentially taking on this role. He felt the conference needed a home with an organization that is dedicated to the study of karst phenomena and designed to conduct and host conferences. While NCKRI now manages this conference, the Organizing Committee of distinguished karst engineers and scientists from around the USA remains intact. The success of this meeting is the result of their fabulous work.

This year’s Sinkhole Conference offers an excellent series of papers, thought-provoking keynote addresses, a fascinating and fun field trip, and ample time for you to meet new and old friends to discuss and collaborate on karst engineering and environmental research projects. Don’t forget to visit the booths of our generous exhibitors and sponsors and support them for supporting the Sinkhole Conference! If you have any questions or concerns about the meeting, please tell us directly or leave a message at the registration desk and we will address them as soon as possible. We look forward to visiting with you soon.

Sincerely,

George Veni
Conference Co-chairman
Executive Director
National Cave & Karst Research Institute

James W. LaMoreaux
Conference Co-chairman
President
P.E. LaMoreaux and Associates
History of Conference

The First Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst was held in Orlando, Florida, October 15-17, 1984. Subsequently, a second and third conference was held under the sponsorship of the Florida Sinkhole Research Institute, a division of the University of Central Florida in Orlando, in 1987 and 1989. These conferences were established to meet a critical need for applied research information on the very complex hydrogeological environment of karst areas of the world.

In 1992, Dr. Barry F. Beck, the former director of the Florida Sinkhole Research Institute, joined the staff of P.E. LaMoreaux & Associates, Inc. (PELA) and opened the company's Oak Ridge, Tennessee office. Beginning with the Fourth Multidisciplinary Conference in 1993, PELA sponsored the continuation of this important series of conferences along with many other distinguished organizations. The Geo-Institute of the American Society of Civil Engineers took the lead in sponsoring the conference in 2003, 2005, and 2008 after which PELA took over the sponsorship again for the 2011 conference. Since the 2011 conference, this conference series has come under the management of the National Cave and Karst Research Institute (NCKRI). As a government-established non-profit organization, NCKRI is focused on karst phenomena and organized in part to conduct and support such conferences; PE LaMoreaux & Associates, Inc., as cosponsor, and the Organizing Committee remain an integral part of the conference.

The proceedings of these conferences have been valuable additions to karst libraries around the world. Below is a list of the proceedings from the beginning conference to 2011 which details the topics covered and the sponsors of each:

Previous Conferences and Proceedings

(1st, 1984, Orlando, FL)
Sinkholes: Their Geology, Engineering and Environmental Impact
Proceedings of the First Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Orlando, Florida, October 15-17, 1984, Edited by Barry F. Beck; Sponsored by Florida Sinkhole Research Institute, College of Engineering, University of Central Florida.

(2nd, 1987, Orlando, FL)
Karst Hydrogeology: Engineering and Environmental Applications
Proceedings of the Second Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Orlando, Florida, Feb. 9-11, 1987; Edited by Barry F. Beck & William L. Wilson, Assisted by Laura Feldman, Shannon Joyce, Kathy McDonald & Sharron Mikesell; Sponsored by Florida Sinkhole Research Institute, College of Engineering, Univ. of Central Florida.

(3rd, 1989, St. Petersburg Beach, FL)
Engineering and Environmental Impacts of Sinkholes and Karst
Proceedings of the Third Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, St. Petersburg Beach, Florida October 2-4, 1989 Edited by Barry F. Beck, Assisted by Adrianne Hagen, Scott Cavin, Brian Barfus & Virginia Merkle; Sponsored by Florida Sinkhole Research Institute, Division of Sponsored Research, and University of Central Florida.
(4th, 1993, Panama City, FL)
Applied Karst Geology

(5th, 1995, Gatlinburg, TN)
Karst GeoHazards: Engineering and Environmental Problems in Karst Terranes
Proceedings of the Fifth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Gatlinburg, Tennessee, April 2-5, 1995; Edited by Barry F. Beck, Assisted by Felicity M. Pearson; Sponsored by P.E. LaMoreaux & Associates, Inc., National Ground Water Association, American Society of Civil Engineers (Tennessee Section); University of Tennessee Institute for Geotechnology, and Karst Waters Institute

(6th, 1997, Springfield, MO)
The Engineering Geology and Hydrogeology of Karst Terranes

(7th, 1999, Harrisburg/Hershey, PA)
Hydrogeology and Engineering Geology of Sinkholes and Karst—1999

(8th, 2001, Louisville, KY)
Geotechnical and Environmental Applications of Karst Geology and Hydrology—2001
Proceedings of the Eighth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Louisville, Kentucky, April 1-4, 2001; Edited by Barry F. Beck and J. Gayle Herring; Sponsored by P.E. LaMoreaux & Associates, Inc., Geo-Institute of the American Society of Civil Engineers, Association of Ground Water Scientists and Engineers of the National Ground Water Association

(9th, 2003, Huntsville, AL)
Geotechnical Special Publication No. 122

(10th, 2005, San Antonio, TX)
Geotechnical Special Publication No. 144
Proceedings of the Tenth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, San Antonio, Texas, Sept 24-28, 2005; Edited by Barry F. Beck; Sponsored by, Geo-Institute of the American Society of Civil Engineers, The Edwards Aquifer Authority, P.E. LaMoreaux & Associates, Inc., Co-Sponsored by The Southwest Research Institute

The 13th Multidisciplinary Conference on Sinkholes and the Engineering & Environmental Impacts of Karst
(11th, 2008, Tallahassee, FL)
Geotechnical Special Publication No. 183
Proceedings of the Eleventh Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Tallahassee, Florida, Sept 22-26, 2008; Edited by Lynn B. Yuhr, E. Calvin Alexander, Barry F. Beck; Sponsored by Geo-Institute of the American Society of Civil Engineers.

(12th, 2011, St. Louis, MO)
Carbonates and Evaporites volume 27, nos. 2-3
Proceedings of the Twelfth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, St. Louis, Missouri, January 10-14, 2011; Edited by Lynn Yuhr and James Kaufman; Sponsored by P.E. LaMoreaux and Associates.
In Memory of Dr. Barry F. Beck, PhD, CPG
October 18, 1944 - November 28, 2011

This series of Multidisciplinary Conferences on Sinkholes and the Engineering and Environmental Impacts of Karst was founded in 1984 by Dr. Barry F. Beck, who was then Director of the Florida Sinkhole Research Institute at the University of Central Florida in Orlando. Barry continued to organize and lead this conference series while serving as Vice-President for Karst and Chief of Operations for the Oak Ridge, Tennessee, office of P.E. LaMoreaux & Associates, Inc. (PELA).

Barry was the primary force behind the first 11 “sinkhole conferences”. In 2009, a stroke interrupted his planning for the 12th conference in January 2011, and medical complications from that stroke ultimately claimed his life in November 2011. As part of the 13th conference, a special memorial session will be held on Wednesday, May 8 at 5:00 pm that will include technical presentations about some of Barry’s karst studies and remembrances by those that knew and worked with Barry.

This memorial page celebrates Barry’s life and the legacy he left for those who live and work in karst. It also introduces him to those who never had the pleasure to know him. The Barry F. Beck Sinkhole Conference Student Scholarship has been established in his memory.

The following obituary appeared in the August 2012 issue of NSS News and is reprinted here with permission.

Dr. Barry F. Beck passed away at the age of 67, following a series of severe blood disorders and a brain stem stroke. The stroke in 2009 left him debilitated with "Locked-in Syndrome."

Born in Hershey, Pennsylvania, Barry was raised by his parents, Daniel and Verna Beck, in an economically challenged neighborhood in Rochester, New York. He earned a Bachelor's degree in geology at Rensselaer Polytechnic Institute, followed by Master's and PhD degrees in geology from Rice University, Texas. His thesis and dissertation focused on the caves and karst of central Texas.

The beginnings of Barry’s interest in caves and karst are uncertain, but that interest grew during his time at Rice University in the late 1960s. He was an advisor to a Boy Scout Explorer Post from the Houston area and led them on caving trips in Texas, Mexico, and other areas. In July 1969, Barry joined the National Speleological Society (NSS) and the Texas Speleological Association, where he served as chairman in 1971. He was instrumental in founding the short-lived Rice University Grotto and was a member of the Texas caving organization known as Carta Valley S.U.C.K.S. (Society of Underground Cavers, Karstologists and Speleologists). Foreshadowing events to come, Texas cavers bestowed Barry with the nickname “Rain God” because his participation in numerous caving trips seemed to invite heavy rain and associated challenges. During one expedition, several vehicles were washed from a campsite and nearly floated down the Colorado River, after which he was presented with a high water warning device.

After receiving his PhD in 1972, Barry's interest in caves led him and his family (including first wife Pat and son Erik) to Puerto Rico, where Hans and Jenny were born. In Puerto Rico, Barry worked for the Department of Natural Resources, conducting investigations in tropical karst and assessing the commercial potential of the Aguas Buenas Caves. He was active in the study and exploration of the Rio Camuy Cave system and studied the sea-margin caves on Isla Mona. Barry also hosted numerous expeditions for cavers exploring Puerto Rico and provided lodging (sofas and floors at his house) and transportation. Barry played a significant role in the attempt to rescue Francis McKinney, who fell 75 feet to his death while climbing from a pit in the Rio Camuy Cave System in 1975.
In 1976, Barry joined the Georgia Department of Natural Resources in Atlanta, where he applied electrical resistivity geophysical techniques to the detection of caves and other karst features. Subsequently, he moved to Americus, Georgia where he taught geology, hydrology, and geomorphology at Georgia Southwestern College (now known as Georgia Southwestern State University). He also met Dr. Penny Lukin, who would become his second wife and the love of his life, and had two more children, Daniel and Sonja.

During the late 1970s and early 1980s, Barry served as a review/associate editor for the NSS News and exploration editor for the NSS Bulletin. He was selected as a Fellow of the NSS in August 1977. Barry authored An Introduction to Caves and Cave Exploring in Georgia in 1980 and edited the proceedings of the Eighth International Congress of Speleology in 1981.

In 1981, Barry became the first and only director of the Florida Sinkhole Research Institute at the University of Central Florida in Orlando. In that capacity, Barry applied his research to the geotechnical and environmental issues associated with sinkhole collapse, land subsidence, and karst groundwater flow. In 1984, he organized the first in a series of Multidisciplinary Conferences on Sinkholes and the Engineering and Environmental Impacts of Karst™. The first four “sinkhole conferences” were held in Florida.

In 1992, Barry joined P.E. LaMoreaux & Associates, Inc. (PELA), where he served as Chief of Operations for the Oak Ridge office and Vice-President for Karst. He managed a variety of sinkhole and karst consulting/research projects throughout the U.S. and around the world. He authored or coauthored numerous technical papers and articles on karst topics. With significant support from PELA, he continued to direct the sinkhole conferences, edit the proceedings, and host the meetings in karst regions around the U.S. Barry was the primary force behind the first 11 “sinkhole conferences”. His stroke interrupted his planning for the 12th conference, which was held in St. Louis in 2011. The National Cave and Karst Research Institute (NCKRI) is taking the lead to continue Barry’s legacy, hosting the 13th conference in Carlsbad, New Mexico during May 2013.

Barry was a member of the East Tennessee Grotto and explored caves in east Tennessee, as well as those associated with his project work around the world. In 2004, the NSS presented Barry with an Honorary Membership for his lifetime of contributions to the study of speleology and karst.

In addition to his professional endeavors, Barry was a loving father to Erik, Jenny, Hans, Sonja, and Daniel. He was an active, energetic, and passionate individual, biking or running almost daily. He was also an avid hiker and tennis player. Barry and Penny shared a passion for dancing, specifically clogging and various forms of folk dancing. At one time, Barry served as President of the Muckalee Mudstompers, a clogging group in Americus, Georgia. Barry loved to explore the world through travel, visiting karst regions in China, Guam, Italy, eastern Europe, Russia, Kuwait, and Argentina.

In 2010, the Weather Channel devoted an episode of "Storm Stories" to an incident in which Barry lived up to his “Rain God” nickname during a March 1979 trip to Anderson Spring Cave in Walker County, Georgia. Barry and six of his students from Georgia Southwestern spent 28 hours trapped underground when heavy precipitation caused flash flooding that completely submerged the cave’s only entrance. Interviews shown in that documentary were recorded just days before the stroke that would trap Barry in his own body for the final two years of his life.

Barry leaves behind family, friends, and associates that will miss him and remember him fondly. His contributions to caves and karst will continue.

Memorial contributions may be made to the Nature Conservancy and earmarked for the Barry Beck Memorial Fund (http://tinyurl.com/barrybeck), which is designated for preservation of karst areas and research on caves and sinkholes. Memorial contributions to the Barry F. Beck Sinkhole Conference Student Scholarship (https://sites.google.com/site/sinkholeconference2013) will support the participation and professional development of at least one student at each conference.

Art Pettit, NSS #18565RL
J. Brad Stephenson, NSS #22755RL
Dr. Penny Lukin
Jim McLane, NSS #14628RG
Carl Kunath, NSS #6230RE (PH-FE)
Dr. Brian Smith, NSS #15208RE
Dr. Wanfang Zhou
Barry F. Beck Sinkhole Conference Student Scholarship

The Barry F. Beck Sinkhole Student Scholarship (Beck Scholarship) is a competitive grant awarded to one or more students who presents the results of their research at the bi-annual Sinkhole Conference. The award is being inaugurated at this year’s conference in memory of the late Dr. Barry Beck, a pioneer in the scientific study of sinkholes who founded the Sinkhole Conference.

At least one Beck Scholarship will be awarded for the conference. Additional scholarships may be awarded if funded from donors for the conference. Beck Scholars receive:

1. One free Sinkhole conference registration.
2. One free registration to a field trip and short course (pending space availability).
3. An award certificate.
4. Recognition through name badge ribbon, mention in the Sinkhole Conference program and website, and announcements at the opening ceremony and banquet.
5. Reimbursement for up to $1000 of personal individual travel, food, and lodging expenses associated with attending the Sinkhole Conference.

For more information about the Beck Scholarship and to fund future scholars, watch future Sinkhole Conference websites or contact the National Cave and Karst Research Institute at info@nckkri.org or by calling 575-887-5518.
Barry F. Beck Sinkhole Conference Student Scholarship Recipient

Dr. Marco Vattano, PhD (MSc Student)
Department of Earth and Sea Sciences, University of Palermo, Italy

Marco Vattano was born on 23 December 1973 in Catania (Sicily, Italy), where he grew up and graduated from high school. Then he moved to Palermo, where he began his graduate studies. In Palermo he began his caving activities thanks to a course organized by the Italian Alpine Club in 1996. Marco Vattano graduated with first class honors in 2005 in the Geology and Geodesy Department, Faculty of Science, University of Palermo, Italy. He then earned his Professional Geologist registration. In 2006, he started his PhD in Geology at the University of Palermo and in 2009 he successfully completed his thesis “Geomorphological evolution of evaporite karst areas in South-Central Sicily by relationship analysis between hypogean karst landforms and surface landforms”. Between 2006 and 2007, Marco was supported by a fellowship sponsored by the Istituto Nazionale di Geofisica e Vulcanologia (INGV) of Palermo, concerning the geochemistry of dissolution waters in gypsum karst systems. In 2009, he won a four-year post-doctoral position funded by the Earth and Sea Sciences Department of the University of Palermo. During this period his research has mainly focused on the understanding of the geomorphologic evolution of karst areas in Sicily. He has been involved with karst and environmental studies in Italy, Spain, Russia, and Mexico. In the future, Marco would like to broaden his knowledge of sinkholes, learning new and more advanced techniques for monitoring, modeling, and prediction of sinkhole formation and development.

Photo courtesy of M. Vattano.
Organizing Committee

General Conference Co-Chairs
- George Veni, Ph.D., P.G., National Cave and Karst Research Institute (NCKRI), Carlsbad, NM
- Jim LaMoreaux, Ph.D., P.E. LaMoreaux & Associates, Inc., Tuscaloosa, AL

Program Co-Chairs
- Lynn B. Yuhr, P.G., Technos, Inc., Miami, FL
- Lewis Land, Ph.D., New Mexico Bureau of Geology & Mineral Resources and National Cave and Karst Research Institute, Carlsbad, New Mexico

Proceedings Managing and Assistant Editors
- Lewis Land, Ph.D., New Mexico Bureau of Geology & Mineral Resources and National Cave and Karst Research Institute, Carlsbad, NM
- Daniel H. Doctor, Ph.D., U.S. Geological Survey, Eastern Geology & Paleoclimate Science Center, Reston, VA
- J. Brad Stephenson, P.G., L.R.S., CB&I, Knoxville, TN

Field Trips
Lewis Land, Ph.D., New Mexico Bureau of Geology & Mineral Resources and National Cave and Karst Research Institute, Carlsbad, NM

Short Courses
E. Calvin Alexander, Jr., Ph.D., Department of Earth Sciences, University of Minnesota, Minneapolis, MN

Invited Speakers
Yongli Gao, Ph.D., University of Texas-San Antonio, San Antonio, TX

Beck Scholarship
- E. Calvin Alexander, Jr. Ph.D., Department of Earth Sciences, University of Minnesota, Minneapolis, MN
- Dianne Joop, National Cave and Karst Research Institute, Carlsbad, NM
- Ira D. Sasowsky, Ph.D., P.G., Geosciences, University of Akron, Akron, OH

Beck Memorial
- Jim LaMoreaux, Ph.D., P.E. LaMoreaux & Associates, Inc., Tuscaloosa, AL
- Dianne Joop, National Cave and Karst Research Institute, Carlsbad, NM
- Brian Smith, Ph.D., Barton Springs/Edwards Aquifer Conservation District, Austin, TX
- J. Brad Stephenson, P.G., L.R.S., CB&I, Knoxville, TN
Conference Management
- Dianne Joop, National Cave and Karst Research Institute, Carlsbad, NM
- Debbie Herr, National Cave and Karst Research Institute, Carlsbad, NM
- Suzanna Langowski, National Cave and Karst Research Institute, Carlsbad, NM

Circulars and Publicity
- Samuel V. Panno, CGWP, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, IL
- Harry L. Moore, P.G., Golder Associates, Atlanta, GA

Program with Abstracts
- Brian Smith, Ph.D., Barton Springs/Edwards Aquifer Conservation District, Austin, TX
- Brian Hunt, Barton Springs/Edwards Aquifer Conservation District, Austin, TX

Website
- Dianne Joop, National Cave and Karst Research Institute, Carlsbad, NM
- Gheorghe Ponta, P.G., P.E. LaMoreaux and Associates, Tuscaloosa, AL

Session Chairs
- Engineering and Geotechnical Aspects of Karst - Joe Fischer, Ph.D., P.E., Geoscience Services, Clinton, NJ
- Evaporite Karst - Ken Johnson, Oklahoma Geological Survey, Norman, OK
- Geophysical Exploration in Karst Terrane - Mustafa Saribudak, Ph.D., P.G., Environmental Geophysics Associates, Austin, TX
- Formation Processes of Karst and Sinkholes - Harry L. Moore, Golder Associates, Atlanta, GA
- Hydrological Aspects of Karst - Geary Schindel, P.G., Edwards Aquifer Authority, San Antonio, TX
- Mapping and Management of Karst Regions - Samuel V. Panno, CGWP, Illinois State Geological Survey, Prairie Research Institute, University of Illinois, Champaign, IL

Session Subcommittees
- Tony Cooley, P.E., P.G., EEC-DEP Division of Waste Management, Solid Waste Branch, Closure Section, Frankfort, KY
- Jeff Schaumburg, P.E., Dynamic Earth, Chester, NJ
- Phil Carpenter, Ph.D., Dept. of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, IL
- Thomas L. Dobecki, Ph.D., P.G., SDII Global Corporation, Tampa, FL
- Bruce Smith, U.S. Geological Survey, Denver Federal Center, Denver, CO
Host City: Carlsbad, New Mexico

Carlsbad is a small but friendly community in southeastern New Mexico, with a population of about 30,000 people. The town was founded in the late 1800s by ranchers from west Texas, along a reach of the Pecos River where flow is supplied in part by karst springs in the bed of the river. The major industries in Carlsbad include tourism, potash mining (southeastern New Mexico contains the United States’ largest known concentration of potash reserves), oil and gas production, agriculture, and activities associated with the Waste Isolation Pilot Plant (WIPP), a disposal facility for defense-related transuranic radioactive waste.

During the time of the conference, daytime high temperatures are likely to range between 80-95 °F (27-35 °C) with overnight lows of 50-70 °F (10-21 °C). Rain is unlikely but expect possible strong winds.

Among people interested in caves and karst, “Carlsbad” is synonymous with “Carlsbad Caverns National Park,” located only 30 minutes by car to the southwest along Highway 62/180. Another 30 minutes farther and into Texas is Guadalupe Mountains National Park. These parks offer world-class views of middle Permian geology and hypogenic karst. Highway 62/180 traverses a striking and unique gypsum karst terrane that includes Parks Ranch Cave, the second-longest gypsum cave in the United States.

In downtown Carlsbad is the Carlsbad Museum and Art Center, which has an interesting exhibit on the region’s history and often hosts excellent special or traveling exhibits. At the city’s north end is the Living Desert State Park and Zoo, a beautifully developed display of flora and fauna of the desert southwest region of the U.S. About an hour’s drive farther north, and especially if you fly in via Roswell, a visit to the International UFO Museum and Research Center is always entertaining.
Generalized map of Carlsbad and locations of Sinkhole Conference venues.
Conference Location:

National Cave and Karst Research Institute (NCKRI)
400-1 Cascades Avenue
Carlsbad, New Mexico, 88220-6215 USA
http://www.nckri.org
Tel: 00.1.575.887.5518

NCKRI Headquarters is located near the center of Carlsbad along the Pecos River. It is part of a new social and retail center for Carlsbad that is currently under construction and is expected to be completed in 2-4 years. Construction of NCKRI is also on-going, but not during the conference, with plans underway to fill the main hall and lobby with interactive museum exhibits.

Conference sessions and most events, including three of the short courses, will be located on the ground floor. One workshop will be held upstairs. General conference information and pick-up of information is located just inside the lobby at the entrance to the future bookstore area. The poster sessions will be held in the future bookstore. For on-site registration and information if the ground floor desk is not occupied, please go upstairs to the office reception desk.

Amenities at NCKRI Headquarters include free wireless Internet (no password needed), a Speakers’ Ready Room in the office behind the ground floor registration desk if you need a quiet space to review your presentation, bottled water and soft drinks in the refrigerator in the conference room, and hot drinks and snacks in the main hallway. NCKRI is also proud to host the conference in its environmentally-friendly facility. For details, ask any NCKRI staff member about the water and energy-saving features, as well as the recycled, low-VOC, and sustainability-produced materials.
Field Trips

Waste Isolation Pilot Plant
Monday, May 6, 7:00 am – 1:30 pm and repeated on Thursday, May 9, 7:00 am – 1:30 pm

Trip Leaders: WIPP Staff

Assemble at: Stevens Inn 7:00 am; Fairfield Inn 7:15 am. Bus will proceed to Skeen-Whitlock (Department of Energy) Building for orientation and transfer to DOE vans.

On Monday morning, we are offering an underground tour of the Waste Isolation Pilot Plant (WIPP) east of Carlsbad for 10 people maximum for the Monday trip and 20 people maximum for the Thursday trip. The Waste Isolation Pilot Plant is currently the nation’s only repository for permanent disposal of defense-related transuranic radioactive waste. A shuttle will provide transport to the WIPP site in eastern Eddy Co., where attendees will have the unique opportunity to tour the site both on the surface and 650 meters below ground level (generally public tours of WIPP are not available). This half-day activity will include a guided tour of surface operations, followed by an underground tour of the repository rooms, which have been excavated in bedded salt of the upper Permian Salado Formation. Attendees may collect hand samples of halite from the drifts at no charge. Lunch is available for purchase in the WIPP cafeteria after the underground tour.

The Salado was chosen as the host formation for WIPP because salt deforms in a ductile manner under high confining pressure. After the waste is deposited in the repository rooms, the salt will eventually (after a few years to decades) flow and envelop the canisters, crushing them and entombing the stored waste. The impermeable nature of rock salt prevents waste from leaking out of the repository and contaminating surface or groundwater resources. Abundant surface karst features are developed in the overlying Rustler Formation a few kilometers west of the WIPP site. Extensive research by Sandia National Lab and the Department of Energy indicates that a connection between these surface features and the WIPP repository is unlikely.

Note that for foreign nationals to attend they must have completed and submitted an Unclassified Foreign Visitor form no later than 15 March 2013, and provide a copy of their passport or visa and a photo ID when they arrive.
Geologists and engineers discuss permanent storage of transuranic waste (in the containers in the background) in deeply buried salt at WIPP. (Inset photo) Visitors at WIPP are welcome to collect their own samples of Permian age salt from the walls of the storage facility (photos: National Cave and Karst Research Institute).

Evaporite Karst of the Lower Pecos Valley

Tuesday, May 7, 7:00 am – 5:30 pm
Trip Leader: Lewis Land

Assemble at Stevens Inn, 6:45 – 7:15 am; bus departs promptly at 7:15. Assemble and board bus at Fairfield Inn, 7:20 - 7:30 am; bus departs promptly at 7:30 am.

On Tuesday we offer a full-day surface tour of sinkholes and other gypsum karst features of the lower Pecos valley between Carlsbad and Roswell, NM. Evaporite karst processes have played a fundamental role in shaping the geomorphology of the lower Pecos region and controlling groundwater flow patterns. This trip will focus on engineering and environmental hazards associated with gypsum karst, including the formation of
anthropogenic sinkholes associated with brine well operations, and the role of evaporites as confining beds in the Roswell Artesian Basin. The trip will end at Bottomless Lakes State Park east of Roswell, where giant gypsum cenotes serve as groundwater discharge outlets at the downstream end of the regional artesian aquifer system in the Roswell Basin. Box lunch provided. Hats, sunglasses, sunscreen, and sturdy shoes are advised.

Loco Hills Sinkhole during its initial collapse before swallowing some of the adjacent storage ponds. This sinkhole was later filled and the site will be visited during the Evaporite Karst field trip. Photo: National Cave and Karst Research Institute.

**Walking Tour of Carlsbad Cavern Big Room**
Friday, May 10, 12:30 – 5:30 pm

Trip Leader: George Veni

Buses depart from NCKRI at 12:30 pm.

On Friday afternoon we are offering a walking tour of the Big Room in Carlsbad Cavern, a classic example of hypogenic-sulfuric acid speleogenesis. A shuttle will depart from the conference center at 12:30 pm. Lunch will be available for purchase at the Carlsbad Caverns visitors center, and the tour will begin after lunch at 2:00
pm. Return to NCKRI will be at 5:30 pm. Access will be via elevator into the Big Room 230 m below ground level. Carlsbad Cavern is generally considered to be one of the most spectacularly-decorated large caves on earth, and is a UNESCO-designated World Heritage Site. The cave is developed in the middle Permian Capitan Reef Formation and associated backreef carbonates. Primary sedimentary structures associated with the Capitan Reef are still visible in the Big Room. A complete circuit of the Big Room will take about 2.5 hours on paved trails. The park provides in-cave artificial lighting, but the cave experience is greatly enhanced when visitors also bring their own light source.

Carlsbad Cavern natural entrance, National Park Service photo by Peter Jones
Short Courses
Monday, May 6, 2013

Grouting in Karst Terrane

Instructors:
Joseph A. Fischer, P.E., Geoscience Services
Matt VanRensler, P.E., Compaction Grouting Services

Location: NCKRI Conference Room A

Course length: 4 hours (8:30am to 12:30pm)

In the U.S., the term karst terrane describes landscapes formed through the dissolution of carbonates at or near the surface. Thus, karst terrane mineral composition and structural conditions vary greatly, making environmental hazards challenging remediation scenarios. This short course focuses on grouting alternatives in karst terrane remediation. Participants will receive an overview of the characteristics of various subsurface conditions in relation to their impact on remediation alternatives and a review of various grouting techniques, materials, and equipment types. Instructors will present various grouting techniques including, grouting with high mobility grout, compaction grouting with low mobility grout, and the advantages of onsite mixing. Participants will gain insight to the advantages and disadvantages of grouting and drilling methods, as well as the pros and cons of various techniques from the prospective of both the grouting contractor and the geotechnical engineer. Participants will also gain an understanding for establishing grouting programs, preparing specifications, estimating drilling / grout requirements, and evaluating results.

Hydrophysics—Logging Wells in Karst

Using Advanced Borehole Geophysical and Hydrophysical Methods to Vastly Improve Groundwater Quality and Supply Investigations.

Instructor: William Pedler, President of RAS, Integrated Subsurface Evaluation

Location: NCKRI Conference Room A

Course length: 4 hours (1:00pm – 5:00pm)

Accurately characterizing heterogeneous aquifers - specifically the water bearing intervals - can be extremely challenging. However, despite these challenges, advanced methods for characterizing subsurface flow have been developed and are being applied on a routine basis in a wide variety of aquifer and borehole settings. Integration of traditional borehole geophysical methods, borehole image logs (acoustic and optical), hydrophysical logs, and hydrogeologic methods (single or straddle wireline packer systems) can provide a
detailed understanding of the geology, structure, vertical hydraulic gradient and vertical distribution of water quality associated with the active water bearing units.

Important applications for integration of these methods include characterization studies associated with contaminated sites (RIFS); wellhead protection; water supply impacts related to resource development; and improved management of groundwater in relation to municipal, industrial and agricultural activities. These data have also been used in the development of defensible groundwater and aquifer monitoring programs.

Students will learn when and how to apply methods to improve the understanding of subsurface flow in karst hydrogeologic settings. The discussion will include a several case studies.

Environmental Investigations and Management of Karst Terranes

Instructors:
Geary M. Schindel, P.G., Chief Technical Officer, Edwards Aquifer Authority, San Antonio, Texas
E. Calvin Alexander, Jr., Ph.D., Professor of Earth Sciences, University of Minnesota, Minneapolis, Minnesota

Location: NCKRI Conference Room B

Course length: 7 hours (8:30am – 4:30pm)

Karst aquifers are self-organizing triple permeability systems. Karst aquifers present difficult problems for resource management, environmental protection, and site investigation efforts. This course emphasizes applied techniques for investigating environmental problems in karst. Participants will gain an understanding for the design and implementation of source water protection programs, hazardous materials release, emergency response, as well as spatial / temporal design and evaluation of groundwater monitoring systems. Instructors will discuss various systems including sentinel water quality parameters and monitoring equipment and techniques. Participants will gain insight on the application of surface and borehole geophysics, tracer testing, well construction techniques, and best management practices for urbanization of karst terranes. Instructors will use case histories from karst aquifers across the U.S. as learning models.

Electrical Resistivity Methods as a Tool for Investigations of Karst Phenomena

Instructors:
Lewis Land, Ph. D., Karst Hydrologist, New Mexico Bureau of Geology

Location: NCKRI Board Room (second floor) and in the field

Course length: 7 hours (8:30 am – 4:30 pm)
This course will provide a one-day overview of the electrical resistivity method as applied to investigations of surface and subsurface karst phenomena. A morning classroom session will briefly describe theory and practice of the electrical resistivity method and its relationship to other geophysical techniques. The classroom session will be followed by a trip to the field south of Carlsbad, where students will assist in deployment of an AGI Supersting™ array over a known gypsum cave passage. Students will have an opportunity to enter the cave while in the field. When the survey is complete the class will return to NCKRI offices and participate in downloading and processing the data for final analysis.

Lewis Land conducting electrical resistivity survey of the I&W brine well cavity in Carlsbad; Stop 1 of the Evaporite Karst field trip. Photo: National Cave and Karst Research Institute.
# Program at-a-Glance

<table>
<thead>
<tr>
<th>Day</th>
<th>Monday May 6, 2013</th>
<th>Tuesday May 7, 2013</th>
<th>Wednesday May 8, 2013</th>
<th>Thursday May 9, 2013</th>
<th>Friday May 10, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>7:30-8:00</td>
<td>Registration Opens (7:30am)</td>
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<td></td>
<td>8:00-8:30</td>
<td>WIPP Tour (7:30am-2:00pm)</td>
<td>Short Courses (8:30am-12:30pm)</td>
<td>Karst Formation Keynote: Parise</td>
<td>Plenary Session (8:15am-12:00pm)</td>
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<td></td>
<td>8:30-9:00</td>
<td></td>
<td>Evaporite Karst Field Trip (7:15am-6:00pm)</td>
<td>Plenary Session (8:15am-12:10pm)</td>
<td>WIPP Tour (7:30am-2:00pm)</td>
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<td>12:00-12:30</td>
<td>Lunch On Your Own (12:30 - 1:30pm)</td>
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<td>3:00-3:30</td>
<td>Short Courses (1:00-5:00pm)</td>
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<td>Carlsbad Cavern Field Trip (12:30 - 5:30)</td>
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<tr>
<td></td>
<td>7:00-7:30</td>
<td>Ken Johnson NCKRI Distinguished Lecture (7:30-9:00pm)</td>
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<td>7:30-8:00</td>
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<td></td>
<td>8:00-8:30</td>
<td>NCKRI Distinguished Lecture at Stevens Inn (7:30-9:00pm)</td>
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<td>8:30-9:00</td>
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</table>

Beverage breaks Wednesday at 10:15 am and 3:10 pm, Thursday at 10:00 am and 2:30 pm, Friday at 9:40 am.
## Detailed Program

### Monday, May 6

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>7:30am</td>
<td>Field Trip: Underground tour of Waste Isolation Pilot Plant (WIPP) — 6 hours</td>
</tr>
<tr>
<td>8:30am</td>
<td>Short courses</td>
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<tr>
<td></td>
<td>Grouting in Karst Terranes - 4 hours</td>
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<td></td>
<td>Borehole Hydrogeophysics - 4 hours</td>
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<tr>
<td></td>
<td>Environmental Management of Karst Terranes - 7 hours</td>
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<tr>
<td></td>
<td>Electrical Resistivity Methods - 7 hours</td>
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<tr>
<td>7:30 PM</td>
<td>Ken Johnson: NCKRI Distinguished Lecture; Evaporite Karst (open to public)</td>
</tr>
<tr>
<td></td>
<td>Salt Dissolution and Sinkholes in West Texas and Southeast New Mexico</td>
</tr>
</tbody>
</table>

### Tuesday, May 7

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30am</td>
<td>Field trip: Evaporite Karst of the Lower Pecos Valley</td>
</tr>
<tr>
<td>6:30pm</td>
<td>Welcome reception, Stevens Inn</td>
</tr>
</tbody>
</table>

### Wednesday, May 8

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>8:15am</td>
<td>Introductory remarks - George Veni and Jim LaMoreaux (15 minutes)</td>
</tr>
<tr>
<td>8:30am</td>
<td>Senator Udall’s representative welcoming comments (5 minutes)</td>
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<tr>
<td>8:35am</td>
<td>Keynote Speaker: Engineering Mladen Garašic (40 minutes)</td>
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<tr>
<td></td>
<td>Speleological, Hydrogeological and Engineering Geological Challenges of Tunneling in Karst Areas</td>
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<tr>
<td></td>
<td>Plenary Session: Engineering and Geotechnical Aspects of Karst, Joe Fischer, chair</td>
</tr>
<tr>
<td>9:15am</td>
<td>Robert Denton Jr.</td>
</tr>
<tr>
<td></td>
<td>Towards a karst assessment standard practice</td>
</tr>
<tr>
<td>9:35am</td>
<td>John Pusey Jr.</td>
</tr>
<tr>
<td></td>
<td>Geotechnical case history for sinkhole investigation and stabilization methods along a high pressure petroleum pipeline</td>
</tr>
<tr>
<td>9:55am</td>
<td>E. D. Zisman</td>
</tr>
<tr>
<td></td>
<td>Problems associated with the use of compaction grout for sinkhole remediation in west-central Florida</td>
</tr>
<tr>
<td>10:15am</td>
<td>Break in exhibit hall (15 minutes)</td>
</tr>
<tr>
<td>10:30am</td>
<td>William Bangsund</td>
</tr>
<tr>
<td></td>
<td>Evaluating karst risk at proposed windpower projects</td>
</tr>
<tr>
<td>10:50am</td>
<td>Timothy Siegel</td>
</tr>
<tr>
<td></td>
<td>Application of stability charts and reliability concepts for simplified analysis of a void in soil overlying karst bedrock</td>
</tr>
<tr>
<td>11:10am</td>
<td>E. D. Zisman</td>
</tr>
<tr>
<td></td>
<td>If it’s weight of hammer conditions, it must be a sinkhole?</td>
</tr>
<tr>
<td>11:30am</td>
<td>Joseph Fischer</td>
</tr>
<tr>
<td></td>
<td>Exploratory grouting of a subsurface detention/infiltration system</td>
</tr>
<tr>
<td>11:50am</td>
<td>Robert Bachus</td>
</tr>
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<td>An innovative approach to characterizing, permitting, and constructing landfills in karst geologic settings</td>
</tr>
<tr>
<td>12:10pm</td>
<td>LUNCH (1 hour, 20 minutes)</td>
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<tr>
<td>1:30pm</td>
<td>Keynote Speaker: Regional Geology Harvey R. DuChene (40 minutes)</td>
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<tr>
<td></td>
<td>Geologic Overview of the Permian basin of Southeastern New Mexico and West Texas</td>
</tr>
</tbody>
</table>
## Plenary Session: Evaporite Karst, Ken Johnson, chair

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:10pm</td>
<td>Kenneth Johnson</td>
<td>Salt Karst and Collapse Structures in the Anadarko Basin of Oklahoma and Texas</td>
</tr>
<tr>
<td>2:30pm</td>
<td>Lewis Land</td>
<td>Evaporite Karst in the Permian Basin Region of West Texas and Southeastern New Mexico: The Human Impact</td>
</tr>
<tr>
<td>2:50pm</td>
<td>Kevin Stafford</td>
<td>Evaporite Karst and Hydrogeology of the Castile Formation: Culberson County, Texas and Eddy County, New Mexico</td>
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<tr>
<td>3:10pm</td>
<td><strong>Break in exhibit hall (20 minutes)</strong></td>
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<tr>
<td>3:30pm</td>
<td>Kenneth Johnson</td>
<td>Gypsum Karst Causes Relocation of Proposed Cedar Ridge Dam, Throckmorton County, Texas</td>
</tr>
<tr>
<td>3:50pm</td>
<td>Anthony Cooper</td>
<td>The Role of Sulfate-Rich Springs and Groundwater in the Formation of Sinkholes over Gypsum in Eastern England</td>
</tr>
<tr>
<td>4:10pm</td>
<td>Kenneth Johnson</td>
<td>Gypsum Karst and Potential Problems in Siting Wind Turbines in Blaine County, Oklahoma</td>
</tr>
<tr>
<td>4:30pm</td>
<td>Daniel Doctor</td>
<td>Evaporite Karst in the Black Hills, South Dakota and Wyoming, and the Oil Play in the Williston Basin, North Dakota and Montana</td>
</tr>
</tbody>
</table>

### 5:00 PM Barry Beck Memorial Session (Wine and Cheese reception)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenter</th>
<th>Title</th>
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<tbody>
<tr>
<td>5:00pm</td>
<td>Brian Smith</td>
<td>Presentation on Barry Beck’s work in Puerto Rico</td>
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<tr>
<td>5:20pm</td>
<td>Harry Moore</td>
<td>Presentation of USDOT karst project that Barry was involved with</td>
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<tr>
<td>5:40pm</td>
<td><strong>Open Forum</strong></td>
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</table>

### 6:30pm Manned Poster Session

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Title</th>
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<tbody>
<tr>
<td>Brian Conway</td>
<td>Monitoring Evaporite Karst Activity and Land Subsidence in the Holbrook Basin, Arizona using Interferometric Synthetic Aperture Radar (InSAR)</td>
</tr>
<tr>
<td>Brian Hunt</td>
<td>Cover-Collapse Sinkhole Development in the Cretaceous Edwards Limestone, Central Texas</td>
</tr>
<tr>
<td>Fuping Gan</td>
<td>Integrated geophysical methods for groundwater exploration in a karst areas with our without thin cover - a case study from Tai’an city, Shandong province, China</td>
</tr>
<tr>
<td>Henok Kiflu</td>
<td>Statistical Analysis of GPR and SPT Methods for Sinkhole Investigations in Covered Karst Terrane, West-Central Florida, USA</td>
</tr>
<tr>
<td>Mingtang Lei</td>
<td>Typical methods for forecasting karst collapse in China</td>
</tr>
<tr>
<td>James Neal</td>
<td>Variations in Evaporite Karst in the Holbrook Basin, Arizona</td>
</tr>
<tr>
<td>Kevin Stafford</td>
<td>Clastic sinkhole and pseudokarst development in east texas</td>
</tr>
<tr>
<td>Melinda Faulkner</td>
<td>Delineation and classification of karst depressions using lidar: Fort Hood Military Installation, Texas</td>
</tr>
<tr>
<td>Michael McGee</td>
<td>Challenges and lessons learned from managing a newly developed catastrophic sinkhole Lake located on multiple use managed public land in the lower pecos valley, NM</td>
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<tr>
<td>Mina Rahimi</td>
<td>Locating Sinkholes in LiDAR Coverage of a Glacio-fluvial Karst, Winona County, MN</td>
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<tr>
<td>Ted Smith</td>
<td>Induced Sinkhole Formation Associated with Installation of a High-Pressure Natural Gas Pipeline, West-Central Florida</td>
</tr>
<tr>
<td>Xiaozen Jiang</td>
<td>Characterization of Karst Collapse Hazard based on groundwater fluctuations in Qingyun, Guigang, Guangxi, China</td>
</tr>
<tr>
<td>Yongli Gao</td>
<td>Investigations of Large Scale Sinkhole Collapses, Laibin, Guangxi, China</td>
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<tr>
<td>Xiaozen Jiang</td>
<td>A calibration test of karst collapse monitoring device by Optical Time Domain Reflectometry (BOTDR) technique</td>
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**Thursday, May 9**

7:00pm  14th Karst Planning Meeting (concurrent with poster session)

**Thursday, May 9**

7:30am  Underground tour of Waste Isolation Pilot Plant (WIPP) - 6 hours

8:15am  Introductory remarks: George Veni and Jim LaMoreaux (5 minutes)

8:20am  Keynote Speaker: Formation of Sinkholes
        Mario Parise (40 minutes)

**Plenary Session: Geophysical Exploration in Karst, Mustafa Saribudak, chair**

9:00am  Marcus Gary
        Geophysical investigations of the Edwards-Trinity aquifer system at multiple scales: Interpreting airborne and direct-current resistivity in karst

9:20am  Thomas Dobecki
        Subbottom profiling investigation of sinkhole lake structure in Bay and Washington Counties, Florida

9:40am  David Harro
        Improved imaging of covered karst with the multi-electrode resistivity implant technique

10:00am Break in exhibit hall (20 minutes)

10:20am Michael Rucker
        Reconnaissance evaluation of a potential future sinkhole using integrated simple surface geophysics and surface monitoring points

10:40am Philip Carpenter
        Ground-penetrating radar, resistivity and spontaneous potential investigations of a contaminated aquifer near Cancun, Mexico

**Plenary Session: Formation Processes of Karst and Sinkholes part 1, Harry Moore, chair**

11:00am Marco Vattano
        Examples of anthropogenic sinkholes in Sicily and comparison with similar phenomena in southern Italy

11:20am Sam Upchurch
        Development of sinkholes in a thickly covered karst terrane

11:40am Lin Mou
        Paleokarst crust of Ordovician limestone and its capability in resisting water inrushes in coal mines of north China

12:00 Lunch (1 hour 30 minutes)

**Plenary Session: Formation Processes of Karst and Sinkholes part 2, Harry Moore, chair**

1:30pm Calvin Alexander
        Deep time origins of sinkhole collapse failures in sewage lagoons in southeast Minnesota

1:50pm Mingtang Lei
        Emergency investigation of extremely large sinkholes, Maohe, Guangxi, China

2:10pm Gheorghe Ponta
        Karst landforms in the Saraburi Group limestones, Thailand
### Plenary Session: Hydrological Aspects of Karst, Geary Schindel, chair

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Presentation Title</th>
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<tbody>
<tr>
<td>2:50pm</td>
<td>Arnauld Malard</td>
<td>Mapping flood related hazards in karst using KARSYS approach. Application to the Beuchire-Creugenat karst system (JU, Switzerland)</td>
</tr>
<tr>
<td>3:10pm</td>
<td>Jennifer Adkins</td>
<td>Conceptualization of Groundwater Flow in the Edwards Aquifer Through the Knippa Gap Hydrogeologic Constriction, Uvalde County, Texas</td>
</tr>
<tr>
<td>3:30pm</td>
<td>Nico Hauwert</td>
<td>Delineation source areas to cave drips and cave streams in Austin Texas, USA</td>
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<tr>
<td>3:50pm</td>
<td>Brian Cowan</td>
<td>Use of physical and chemical response in cave drips to characterize upland recharge in the Barton Springs segment of the Edwards Aquifer, Central Texas, USA</td>
</tr>
<tr>
<td>4:10pm</td>
<td>Shiloh Beeman</td>
<td>The Need for Presumptive Habitat Considerations in Working with Subterranean Aquatic Species of Concern: Three Ozark Region Case Histories, U.S.A.</td>
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### Plenary Session: Mapping and Management of Karst Regions, Sam Panno, chair

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<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:20am</td>
<td>Mario Parise</td>
<td>Populating a chronological catalogue of sinkholes in Italy, as the first step for assessing the sinkhole hazard</td>
</tr>
<tr>
<td>8:40am</td>
<td>Mario Parise</td>
<td>Lessons learned from occurrence of sinkhole related to man-made cavities in a town of Southern Italy</td>
</tr>
<tr>
<td>9:00am</td>
<td>Kevin Theusen</td>
<td>Restoring Land and Managing Karst to Protect Water Quality and Quantity at Barton Springs, Austin, Texas.</td>
</tr>
<tr>
<td>9:20am</td>
<td>Samuel Panno</td>
<td>The use of drought-induced “crop lines” as a tool for characterization of karst terrane</td>
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<tr>
<td>9:40am</td>
<td>Break in exhibit hall (20 minutes)</td>
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<tr>
<td>10:00am</td>
<td>Harry Moore</td>
<td>Mapping surface and subsurface karst geohazards for highway projects: SR 71 South Knoxville Blvd. Extension, Knox County, TN</td>
</tr>
<tr>
<td>10:20am</td>
<td>George Veni</td>
<td>Government Canyon State Natural Area: An Emerging Model for Karst Management</td>
</tr>
<tr>
<td>10:40am</td>
<td>Scott Alexander</td>
<td>Combining LiDAR, Aerial Photography, and Pictometric Tools for Karst Features Database Management</td>
</tr>
<tr>
<td>11:00am</td>
<td>(Daniel Doctor and John Young)</td>
<td>An evaluation of automated GIS tools for delineating karst sinkholes and closed depressions from 1-m LiDAR-derived digital elevation data</td>
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</tbody>
</table>

**Friday, May 10**

**8:15am** Introductory remarks - George Veni and Jim LaMoreaux (5 minutes)

**Plenary Session: Mapping and Management of Karst Regions, Sam Panno, chair**

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<td>Mapping surface and subsurface karst geohazards for highway projects: SR 71 South Knoxville Blvd. Extension, Knox County, TN</td>
</tr>
<tr>
<td>10:20am</td>
<td>George Veni</td>
<td>Government Canyon State Natural Area: An Emerging Model for Karst Management</td>
</tr>
<tr>
<td>10:40am</td>
<td>Scott Alexander</td>
<td>Combining LiDAR, Aerial Photography, and Pictometric Tools for Karst Features Database Management</td>
</tr>
<tr>
<td>11:00am</td>
<td>(Daniel Doctor and John Young)</td>
<td>An evaluation of automated GIS tools for delineating karst sinkholes and closed depressions from 1-m LiDAR-derived digital elevation data</td>
</tr>
</tbody>
</table>

**12:30pm** Buses depart for Carlsbad Caverns field trip

- Lunch at Carlsbad Caverns visitors center
- Airport shuttle departs for El Paso (departure time TBD)
Invited and Keynote Speakers

Distinguished Lecture: A NCKRI lecture series offered to the general public and Sinkhole Conference attendees

Monday, May 6, 2013, 7:30pm

Salt Dissolution and Sinkholes in West Texas and Southeast New Mexico
Kenneth S. Johnson
Geologist, Norman, Oklahoma

Thick salt deposits have been dissolved intentionally to produce salt-water brines in parts of West Texas and southeast New Mexico, and locally this has created large underground brine-filled cavities. Elsewhere, these salts have been dissolved accidentally during petroleum operations, thus leaving brine-filled cavities similar to those created in brining operations. Since 1980, some of these cavities have collapsed and created large sinkholes near Wink, TX, and the JWS and Loco Hills sinkholes in NM.

Collapse of these earlier cavities has raised concerns about a similar brine cavity in Carlsbad, NM. The I&W brine cavern, located at the “South Y” on the south side of Carlsbad, was ordered closed in 2008 because of its similarity to the JWS and Loco Hills brining operations. A series of geologic and geophysical studies have characterized the probable size, shape, and depth of the underground cavity and the site is now being monitored constantly to provide early warnings in the event of collapse of the cavity.

Biography:
Dr. Kenneth S. Johnson has been studying and characterizing problems related to natural and human-caused dissolution of salt and gypsum through the United States, with special emphasis on occurrences in the southwestern states of Oklahoma, Texas, and New Mexico. Previously, Ken was a research geologist and Associate Director of the Oklahoma Geological Survey at The University of Oklahoma, and now he is a consulting geologist in Norman, Oklahoma. His studies of salt dissolution and resultant collapse features started nearly 50 years ago, and since then he has published about 50 articles and abstracts on these subjects.
Wednesday, May 8, 2013, 8:35am

**Speleological, Hydrogeological and Engineering Geological Challenges of Tunneling in Karst Areas**

**Mladen Garašić**  
University of Zagreb, Croatia

In the Classical Dinaric Karst of Croatia, over 11,500 caves have been explored so far, more than 1,000 of which were discovered during construction works. Caves discovered on the construction sites of highways lacked natural entrances on the surface. Over the past 20 years they have been systematically investigated and remediated to allow completion of the roads. Some special examples will be presented during the lecture, such as the large hall in the Vrata Tunnel of the Zagreb – Rijeka Highway, and caves in Croatia’s longest tunnels. Due to the size, shape, position, and hydrogeological parameters of the cave within the karst system, it was necessary to design and construct a special bridge through the cave in the Vrata Tunnel. The cave’s vaulted ceiling had to be reinforced and stabilized. This presentation will include video and photos of the most interesting karst and cave locations in Dinaric Karst.

**Biography:**
Mladen Garašić, PhD. Geology, Hydrogeology, and Geological Engineering. Born in Zagreb, Croatia, in 1951, Dr. Garašić graduated in geology and karst hydrogeology in 1977, master of science 1981, and doctorate in geosciences and geological engineering in 1986. He is a scientist, and a professor of geology, karst hydrogeology, applied geology, engineering geology and speleology at the University of Zagreb, and has authored more than 330 scientific and professional papers. He serves as a committee member for the Croatian Academy of Science and Arts, UNESCO World Heritage Team for the Dinaric Karst, International Association of Hydrogeologists, and International Association for Engineering Geology and the Environment.

Dr. Garašić started skiing in 1955 and won the Junior Skiing competition of Croatia in 1963. He has been a member of the Croatian Mountaineering Association since 1955 and was awarded by the Association in 1969 and 1981. He started caving in 1963 and is the founder and president of several caving clubs in Croatia. He served as first president of the Croatian Speleological Federation from 1990 to 2010 and is a life member of the U.S. National Speleological Society. Since 1993, he has served as Croatia’s delegate to the International Union of Speleology and to the European Speleological Federation beginning in 2009.

Dr. Garašić has conducted research in, and explored and visited nearly 5,000 caves in 64 countries. He has led many speleological expeditions in the longest and deepest caves in Croatia, Europe, and the world. He has also studies about 1,000 caves without natural entrances, discovered by tunnels and quarries, and evaluated their hydrogeology and engineering geology.
Wednesday, May 8, 2013 1:30pm

Geologic Overview of the Permian Basin of Southeastern New Mexico and West Texas

Harvey R. DuChene
Vecta Oil and Gas, LP

Carlsbad, New Mexico is located in the north-central part of the Delaware basin, which is part of the greater Permian basin, one of the richest oil and gas provinces in the world. In Late Mississippian to Early Pennsylvanian time, the collision of South America-Africa with southern North America caused the Ouachita-Marathon orogeny and formed the deep structural basins and uplifts of the ancestral Rocky Mountains. Material eroded from uplifts progressively filled basins during Pennsylvanian and Permian time. Major structural components of the ancestral Rockies in the Permian basin region are the Midland and Delaware basins, separated by the Central Basin platform.

Paleozoic stratigraphy of the region can be divided into two broad packages. Older Paleozoic strata range from Cambrian to Mississippian age and were deposited in an ancestral depression known as the Tobosa basin. These strata are mostly carbonates and are truncated by a major Late Mississippian to Early Pennsylvanian regional unconformity. Strata of Pennsylvanian and Permian age were deposited in basins formed during the Marathon-Ouachita orogeny. The sediments consisted of interbedded, organic-rich shale, sandstone and carbonate deposited in basins rimmed by carbonate shelf margins. Typically, time-equivalent strata of Pennsylvanian and Permian age grade from mixed lithologies in basin centers to carbonate on shelf margins to mixed evaporite and clastic sediments on the basin shelf. Toward the end of Permian time, thick beds of evaporites were deposited atop older carbonate and clastic strata across the region.

Strata in the Permian basin were repeatedly impacted by changes in climate and sea level. Conditions suited to carbonate deposition dominated during times of high sea level with erosion occurring during times when sea level was low. Low stands were conducive to dissolution of carbonate and the development of karst. Many Permian basin oil fields are profoundly impacted by buried karst (“paleokarst”) which, in some cases, enhanced porosity and permeability. More commonly, paleokarst negatively impacted hydrocarbon reservoirs by causing early encroachment of water along fractures, or by occluding matrix porosity and filling fractures with secondary cement resulting in compartmentalization.

Development of the modern landscape began with the onset of Laramide tectonism in Late Cretaceous and Early Tertiary time. Regional compression caused the gradual rise of a north-trending arch that extended from Wyoming to northern Mexico known as the Alvarado Ridge. Uplift culminated approximately 35 ma when structural failure caused by attenuation of the earth’s crust resulted in the opening of the Rio Grande rift along the axis of the Alvarado Ridge.
As the Alvarado Ridge rose, progressively older strata were stripped from uplands and deposited on the flanks of the arch. Erosion exposed Paleozoic carbonates that became recharge areas for aquifers that introduced meteoric water into the Permian basin. Carbonate aquifers carried oxygenated meteoric water down the east flank of the Alvarado Ridge toward the Delaware basin where it mixed with hydrogen sulfide-rich connate water to form copious sulfuric acid. The acid dissolved vast amounts of limestone, creating the huge caverns of the Guadalupe Mountains such as Carlsbad Cavern. This type of karst is hypogenic, and lacks many of the surface features typical of epigenic karst terranes.

In southeast New Mexico and west Texas, erosion related to the rise of the Alvarado Ridge exposed Permian evaporites. Meteoric water dissolved these evaporites, resulting in karst topography characterized by closed drainage depressions, shallow caves and sinkholes. Evaporite karst is common along the Pecos River and its tributaries, which comprise the principle surface drainage conduit for the region.

The Permian basin has been heavily drilled for petroleum, resulting in the discovery and development of thousands of oil and gas fields. Production of oil and gas requires significant infrastructure, including pipelines, water supply wells, and brine disposal wells. The rapid rate of dissolution of evaporites can damage pipelines and well casings. In some cases, leaking casings in wellbores introduced water into evaporite beds, causing dissolution that resulted in large, near surface cavities. Some of these cavities have collapsed, resulting in man-made sinkholes.

**Biography:**

Harvey DuChene is a graduate of the University of New Mexico, earning B.A. (1968) and M.S. (1973) degrees in geology. He has 39 years of experience as a petroleum geologist, working for Amoco Production Company, Davis Oil, Axem Resources and others. He currently is a limited partner in Vecta Oil and Gas, LP, an oil and gas exploration and production company headquartered in Dallas, Texas. His primary area of expertise is petroleum exploration in basins of the Rocky Mountain province and west Texas, with additional experience in the midcontinent, Appalachian basin and offshore West Africa.

Harvey has also more than 30 years studying the speleogenesis of hypogenic caves, particularly those formed by sulfuric acid. He is interested in the connection between the evolution of hypogenic cave systems and the tectonic and geologic history of regions.

Harvey is a member of the Geological Society of America, American Association of Petroleum Geologists, American Geological Institute, Rocky Mountain Association of Geologists, New Mexico Geological Society, West Texas Geological Association and Karst Waters Institute, and he is a Fellow of the National Speleological Society.
Natural and anthropogenic sinkholes: from identification, to surveying, studying and modeling a subtle hazard

Mario Parise
National Research Council of Italy, Institute of Research for the Hydrogeological Protection

Sinkholes are the most common hazard in karst, being related to the presence of natural caves, and to their interaction with the ground surface. In the last decades, however, the study of sinkholes widened well beyond the boundaries of karst, including situations where cavities produced by man in different epochs and for different purposes interact in some way with the built-up environment, and represent a likely threat to the society. As a matter of fact, several urban areas in many countries worldwide have been recently affected by sinkhole occurrence which caused severe damage; sinkholes in Guatemala City, and other events in Italy, Germany and Turkey are only some of the many that characterize the last several years.

In terms of civil protection issues, the topic has become of high interest in Italy, and much work has been devoted to it at CNR-IRPI. This presentation briefly describes the activities carried out, as they concern both natural and anthropogenic sinkholes, and to share the experiences so far developed. These latter cover all the phases of sinkhole analysis: from the identification of the sinkhole-prone areas, to surveying the underground environment (by combining speleological techniques and modern technologies in order to get reliable and precise surveys), to recognizing the type of rock failures and characterizing the rock mass in terms of mechanical properties, to eventually modeling the case studies through numerical codes in order to forecast the likely evolution of underground failures, their upward propagation, and evaluating the possibility of sinkhole occurrence at the ground surface. A particular focus will be given to historical research, and its use in identifying ancient and/or buried caves, as the first step in the assessment of the sinkhole susceptibility and hazard. All of this will be illustrated through a number of case studies in southern Italy, dealing with natural karst caves and anthropogenic cavities as well. The final part of the presentation will also cover some issues related to land-use problems in sinkhole-prone areas, and the utilization of the outcomes from sinkhole studies in civil protection programs at the local and national level, aimed at safeguarding and protecting private and public properties and the local populations.

Biography:
After graduating with honors in Geology in 1988 at the Faculty of Sciences of the University of Naples, Mr. Parise received grants from the National Research Council of Italy and spent several periods working in cooperation with the U.S. Geological Survey at Golden, Colorado, and the University of South Florida at Tampa, Florida. Since 1994 he has worked as a Research Geologist at the National Research Council, Institute of Research for Hydrogeological Protection (CNR-IRPI) in Bari, Italy. He has organized and convened several international workshops and conferences on the topics of karst, karst hazards, and slope movements.
(European Geosciences Union Assemblies, Geological Society of America Meetings, Italian Forums of Earth Sciences), and is the scientist responsible for several projects between CNR-IRPI and different public administrations and private companies.

Since 1990, Mr. Parise has developed research mainly into the geological and geomorphological analysis of slope movements. Much of his research deals with the identification of areas susceptible to different types of slope movement (debris flows, deep-seated gravitational slope deformations, mass wasting processes, etc.) by means of stereoscopic interpretations of aerial photographs and field surveys. Particular focus is given to multi-temporal analyses, aimed at understanding the likely evolution of slopes, even in relationship with anthropogenic activities, and/or as a consequence of specific triggering events (rainstorm, earthquakes, etc.). For several sites in southern Italy, he has created a framework of the influence of weathering in the predisposition of slope movements. He has also contributed to the analysis of rapid landslides (debris avalanches, rock avalanches) in different geological settings in Italy and abroad, and to studying the occurrence of debris flows and erosional processes in areas recently affected by wildfires.

He began caving in 1998 and since 2002 he also works in the field of karst research, focusing on the evaluation of natural and anthropogenic hazards that occur in karst territories, with particular regard to sinkholes related to both natural caves and man-made cavities. He is the author of over 100 papers published in international journals and proceedings of international conferences. He has given several presentations in international symposia and workshops. Mr. Parise has guest edited 10 special issues for ISI international journals, published two books with the Geological Society of London, and reviews papers for several international journals.

Thursday May 8, 2013, 6:30pm

When the Carbonate Plumbing Goes Bad: Sinkholes, the Hydra, and the General Public

William Kochanov
Pennsylvania Department of Conservation and Natural Resources

In 1985, a program was initiated by the Pennsylvania Geological Survey to inventory (catalog) existing sinkholes and to map areas of potential sinkhole development. The program was developed to provide general background information for the initial stages of site investigations, aid in sinkhole remediation efforts, and serve as a tool for developing regional land-use planning strategies. Although the methods of data collection and distribution have evolved over the past 25 years, it has been interesting to note that the practicing professional continually has had to refine the means of sorting and sifting data much like that of a forensic specialist; each investigator having their own special challenges as the clues for remediation often lie hidden beneath the veneer of urbanization, are squirreled away in files of the local Historical Society or are muted for fear of liability. Bill will take you on a savage journey through the karstlands of Pennsylvania to marvel at some of its many wonders, examine yawning portals to the underworld, grapple with the paradox of the cultural hydra, and the ultimate in trepidation, entering the lair of the general public.
Biography:
William (Bill) Kochanov (pronounced KO-CHAN'-OFF) is a Senior Geologist with the Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey, Geologic Mapping Division. Since 1985, he has been actively mapping geologically hazardous areas within the limestone regions of Pennsylvania and maintains the Bureau’s sinkhole database. He has also conducted bedrock mapping projects spanning much of the Paleozoic from Pennsylvania’s northern anthracite coal field and Endless Mountains Region to the Chester Valley of southeastern Pennsylvania. Bill is most noted for authoring the series of county reports, specifically designed to characterize karst surface features, their distribution, and their relation to physiographic setting. He is strongly involved with the Survey’s outreach programs; translating the geology of Pennsylvania for, as Joe Fischer puts it, “the greater unwashed.” Bill lives in the suburbs of Harrisburg with his wife Jane and children, Natalie and Alex, close to the forests of Stony Creek where he spends many hours tracking down the elusive edibles of the mushroom world.