



2018 - 2019
ANNUAL REPORT

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Cover photo

This spectacular view from Cueva Ventana awaits visitors to Puerto Rico, where NCKRI will organize the *16th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst*. See page 13 for details. NCKRI photo by George Veni.

Back Cover Photo

NCKRI's international partnerships offer opportunities to better understand the diversity of karst landscapes, like these fabulous karst towers along Dahang Grand Canyon, Xiangxi Geopark, Hunan, China. NCKRI photo by George Veni.



Vision and Values

The National Cave and Karst Research Institute (NCKRI) will be the world's premier cave and karst research organization. NCKRI promotes and performs projects of national and international application, of the highest quality and integrity, through dedicated staff and partners.

Organization and Mission

NCKRI was created by the US Congress in 1998 in partnership with the National Park Service, State of New Mexico, and the City of Carlsbad. Federal and state funding for NCKRI is administered by the New Mexico Institute of Mining and Technology (a.k.a. New Mexico Tech or NMT). Funds not produced by agreements through NMT are accepted directly by NCKRI, Inc., our non-profit, 501(c)(3) affiliate.

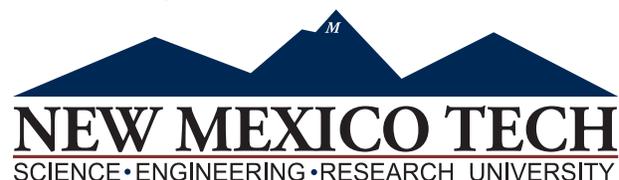
NCKRI's enabling legislation, the National Cave and Karst Research Institute Act of 1998, 16 U.S.C. §4310, identifies NCKRI's mission as to:

- 1) further the science of speleology;
- 2) centralize and standardize speleological information;
- 3) foster interdisciplinary cooperation in cave and karst research programs;
- 4) promote public education;
- 5) promote national and international cooperation in protecting the environment for the benefit of cave and karst landforms; and
- 6) promote and develop environmentally sound and sustainable resource management practices.

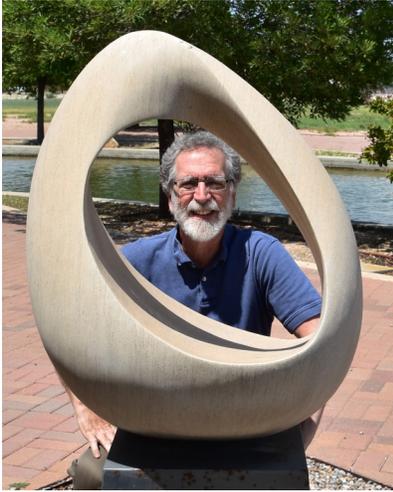
NCKRI Annual Report Series

NCKRI produced this publication as part of its annual reporting of activities. The reporting period covers NCKRI's fiscal year, from July 1, 2018 to June 30, 2019. Digital copies of this and previous reports are available for free at www.nckri.org.

NCKRI is a proud institute of:



EXECUTIVE DIRECTOR'S REPORT



NCKRI photo by Michael Jones.

Continous Line in Space, an abstract cave sculpted in Indiana Limestone by artist Michael Orgel, graces the grounds of NCKRI Headquarters. Its elegant yet occasional unexpected twists reminds me of NCKRI's continuous journey in time.

For far too long NCKRI has advanced with usually limited resources and against occasional adverse conditions. We built our headquarters and hired our initial staff through the recession with money that was saved or already committed, and then much of our growth stopped. We couldn't afford more people or equipment. With the dedication of our staff, board, and great help from our friends, we continued to progress, but slowly.

When the recession ended we saw an uptick in funded projects, capped by tremendous news at the end of last year—we were getting a \$500,000 boost in our federal funding!

In last year's annual report I announced the new funding and thanked New Mexico's US Senator Tom Udall, who made it possible, and also Senator Martin Heinrich for supporting that effort. Since then, we have hired three new and vitally important staff members. A fourth starts a couple of weeks into our next year. We have a literal ton of equipment and supplies on order. Next year's report will boast of a nicely equipped laboratory and more research vehicles.

This year our Education Program was able to organize two temporary exhibits and finalized efforts to complete our outdoor Drop Zone exhibit. Our Research Program saw a major increase in funded contracts for cave and karst studies, including funding to support our students' research. Our Academic Program is skyrocketing with new program director, Dr. Daniel Jones, through his student activities and new grant program, and additional grants planned for next year. Additionally, our New Mexico State Representative Cathrynn Brown was able to add an additional \$50,000 to our state funding for next year!

While most of the year has been great, we were sad to lose our Event Planner, Courtney Gasow, as other obligations took her away from us. She smashed records in rental use of NCKRI's facilities, generating another needed source of revenue. We also struggled with the added work required by the new funding, but it was a good problem to have. In the coming year we'll now have some of the additional staff and tools we have long needed. Our productivity and effectiveness in advancing cave and karst research, education, management, and archiving of data will grow greatly.

On behalf of the NCKRI board and staff, I thank you for your support over the years and in keeping our continuous line through space and time on an upward trajectory.

George Veni, Ph.D.

NCKRI RESEARCH

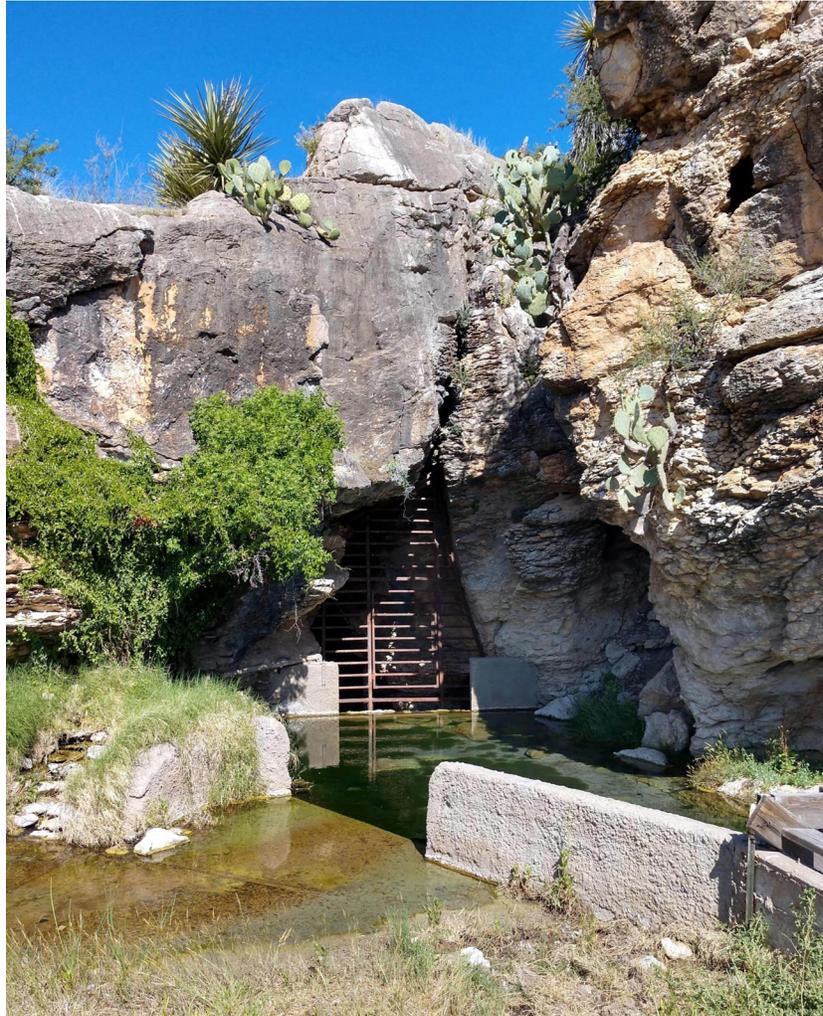
Characterization of the San Solomon Springs' Aquifer

Last year's NCKRI annual report described a preliminary study of the San Solomon Spring Group. Based on that study, NCKRI submitted a proposal to Apache Corporation for an investigation of the hydrogeology of the aquifer that discharges from the springs.

The San Solomon Spring Group is a series of six karst springs that discharge groundwater from Cretaceous limestones along the northeast flank of the Davis Mountains in West Texas. Apache Corporation is in the early stages of developing a major oil and gas discovery in the area, and is funding this study as part of its effort to avoid compromising water resources and water quality of the San Solomon Springs.

The springs and related groundwater provide water resources for much of the agricultural activity in southern Reeves County, Texas. The farthest upgradient spring discharges from Phantom Lake Spring Cave, currently the deepest underwater cave in the United States. The main San Solomon Spring serves as a giant swimming pool and the centerpiece of Balmorhea State Park, another important part of the local economy. The springs also provide habitat for several federally listed endangered species, including the Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*).

The San Solomon Springs are located at the far western edge of the Edwards Plateau and the greater Edwards-Trinity Aquifer System. However, previous research conducted by hydrogeologists at The University of Texas at Austin indicate that the San Solomon Springs occupy a different hydrologic regime that has little to do with the Edwards-Trinity



NCKRI photo by Lewis Land.

Groundwater once flowed naturally from the entrance of Phantom Lake Spring Cave, but since 1993 water from inside the cave has often been pumped into a refugium pool built to preserve habitat for several endangered species.

Aquifer. Based on geochemical, isotopic, and hydrologic data, these scientists concluded that baseflow from the San Solomon Springs originates from groundwater recharge in alluvial basins over 70 km to the west in central Culberson County, Texas. This water then enters and flows through Permian carbonates of the Capitan Reef Complex in the Apache Mountains, and then into Cretaceous rocks juxtaposed by faulting against the Capitan Reef carbonates in the subsurface.

Groundwater first flows from Phantom Lake Spring Cave in northern Jeff Davis County, Texas and subsequently from the five downgradient springs, including from San Solomon Spring into the pool at Balmorhea State Park. In 2013, NCKRI personnel conducted a dye trace of the system, injecting uranine dye into Phantom Lake Spring Cave. The dye appeared in the pool at Balmorhea State Park six days later, indicating that groundwater flows through karstic conduits in Cretaceous limestone

from the cave to the park at a rate of approximately 1,000 m/day.

Although the regional conceptual model is considered plausible by hydrogeologists working in West Texas, specific details of this karstic aquifer system are not well known. For example, during the 2013 dye trace, no dye appeared in the other four downgradient springs, one of

which, Giffin Spring, is located less than 300 m from the park.

The scope of this current 2-year study includes additional dye tracing and a synoptic program of water level measurements and groundwater sampling. This work is supplemented by electrical resistivity (ER) surveys to better characterize groundwater flow paths from Phantom Lake

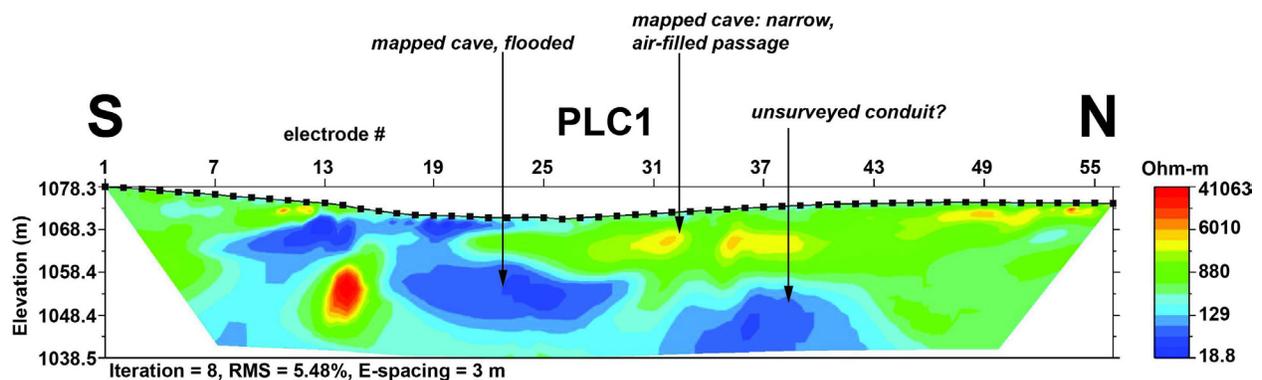
Spring Cave to the five downgradient springs in Reeves County.

Beginning in April 2019, NCKRI's hydrogeologist Dr. Lewis Land and newly-hired Cave and Karst Science Specialist, Michael Jones, began conducting resistivity surveys over mapped portions of Phantom Lake Spring Cave to establish the resistivity signature



NCKRI photo by Lewis Land.

Michael Jones, NCKRI's new Cave and Karst Science Specialist, examines the stream flowing from Giffin Spring, the second highest volume spring in the San Solomon Spring Group.



ER survey PLC1 passes directly over a mapped portion of Phantom Lake Spring Cave between electrodes 19 and 29. The flooded cave passage appears on the ER profile as an elliptical zone of low electrical resistivity.



NCKRI photo by Michael Jones.

Dr. Lewis Land and Angela Lucero, hydrologist with the New Mexico Bureau of Geology and Mineral Resources, collecting resistivity data in a mesquite thicket south of Phantom Lake Spring Cave.

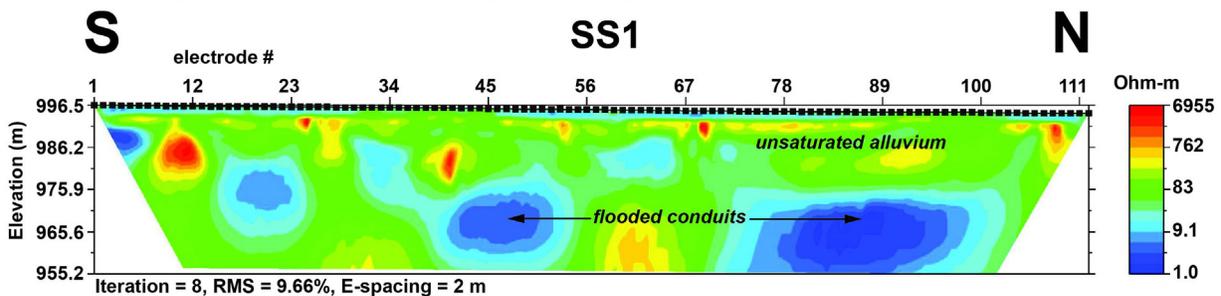
of the cave. Most of the cave is partially or completely flooded with slightly brackish water, and thus appears on ER profiles as a zone of low electrical resistivity.

Subsequent surveys conducted in June 2019, with assistance from personnel with the New Mexico Bureau of Geology and Mineral Resources, identified electrically conductive zones that indicate the flooded passage continues at least 400 m beyond the farthest downgradient station in the mapped portion of the

cave. An ER survey conducted about 350 m west of Balmorhea State Park also identified low resistivity anomalies that probably represent flooded conduits. Combined with the results of the 2013 dye trace and other data, this ER survey strongly supports the presence of karstic conduits between Phantom Lake Spring Cave and San Solomon Spring.

NCKRI's study of this interesting hydrologic system is notable in a variety of ways. Relatively few karst aquifers are supported mostly

by groundwater from an alluvial aquifer. Karst aquifers in semi-arid regions are also understudied, and this research will add to the understanding of aquifers in such areas. We believe this investigation may also establish superior protocols for characterizing karst aquifers in areas of oil and gas production to minimize or prevent any adverse impacts on human water supplies and endangered species habitat. The project will continue through 2019 and 2020.



ER survey SS1 is located approximately 350 m west of Balmorhea State Park. Zones of low resistivity on the ER profile probably represent karstic conduits flooded with brackish water that discharge from San Solomon Spring into the park's swimming pool.

NCKRI Bat Roost Update

NCKRI Headquarters is the only building in the world designed to include a home for bats. It was designed by Mylea Bayless, Artificial Roosts Coordinator for Bat Conservation International (BCI), and Dr. George Veni, NCKRI's Executive Director. NCA Architects adjusted that design to accommodate construction and attachment to the building.

The roost has an optimal design for bats and offers flexibility for study and education. The roost is made of concrete and has six crevices to serve as bat living quarters. Each crevice is 60 cm high, 6.7 m long and 1.9 cm wide. The crevices are divided by 3-cm thick panels. Horizontal slots near the bottom of the panels let bats move from crevice to crevice without leaving the roost, where they could be exposed to predators. The outer walls extend 10 cm below the roost and serve as landing pads for bats to easily access the roost. The roost has space for an estimated 5,000–7,500 bats, but since it was finished in late 2010, no bats have moved in. What's the problem?

BCI's statistics show that 2–5 years are usually needed for bats to find a new roost, so the lack of bats as of the end of June 2019 is a bit of a surprise. Motion-activated infrared cameras have been watching for bats since September 2011, so we know that no bats have discovered the



NCKRI photo by Michael Jones. ***A flash of light captures a blurred bat flying swiftly into the night sky for dinner from its home in the Upper Tansill Dam buttress. Is this roost near NCKRI Headquarters keeping bats from discovering the NCKRI bat roost?***

roost during the past 94 months.

Since the NCKRI roost is past the normal waiting period for discovery by bats, something may be keeping bats away. For the first few years after the roost's construction, the Carlsbad area suffered a major drought. With low rainfall, far fewer insects are in the area. Flying insects are what most bats in the area eat, and with less food, the Carlsbad area has fewer bats. With low bat populations, fewer bats are looking for new homes.

But there may be other possibilities for the bats' absence. For many years, people have seen bats dining on flying insects attracted to street lights and have assumed that bats are also thus attracted to the lights. However, recent research in Britain found that bats avoid the lights. People see the few that stray into the lit areas, but the majority stay far away. Could it be that bats are avoiding the NCKRI roost because of the street lights used for nighttime security?

Another possible factor we discovered this year was a colony of bats emerging from the buttress of the Upper Tansill Dam, located directly on the opposite side of the Pecos River from NCKRI near the Carlsbad Riverwalk Recreation Complex. Maybe it provides enough of a home for bats in the area and the NCKRI roost is extra space they don't need currently?

The NCKRI bat roost wasn't built just to provide a home to these beneficial yet often misunderstood and maligned animals, but to study them too. While we certainly still hope they will occupy our roost, it is just as important that we understand their behavior and roost preferences. Their absence and the possible reasons for it is valuable information.

As we wait for the bats to hang out with us, NCKRI staff have been analyzing eight years' worth of hourly temperature and relative humidity data from dataloggers in three locations in each of the



NCKRI photo by Michael Jones. ***The bat roost at NCKRI Headquarters stands ready to provide a safe shelter for thousands of bats.***

six crevices. While it will be great when the bats arrive, developing a good record of roost conditions before occupation is valuable to its long-term study. This will be useful in better understanding roost conditions after bats move in.

Once the roost is occupied, NCKRI will conduct more public education and research about our bats and bats in general. Data, video, and sounds from the roost will be included as one of NCKRI's museum exhibits, and you will be able to watch the bats on our website!

If you would like to support NCKRI's bat roost research, join our Adopt-A-Bat program. Adopting a bat costs only \$25 and includes a Certificate of Adoption, educational information about bats and our bat roost, and your very own cuddly stuffed bat. All proceeds go to maintenance and equipment needed for the bat roost. We are looking to expand our monitoring program with more and better equipment this coming year and would appreciate your help. For more information on how to help or to adopt a bat, go to www.nckri.org or call 575-887-5518.

Mapping Endangered Karst Species

In 1988, the US Fish and Wildlife Service (USFWS) listed five invertebrate karst species as endangered. These species are only known to occur in the Austin, Texas, area in Travis and Williamson counties. These counties were being rapidly urbanized and many caves were at risk of being sealed, destroyed, or adversely affected by degraded water quality and other impacts. Since 1988, other karst species located about 100 km to the southwest in the San Antonio area have also been listed.

Following the listings, USFWS developed maps that outlined “karst fauna regions,” which contain similar and likely interconnected underground ecosystems, and “karst zones,” which identify the probability of encountering the listed species in any particular area.

The “region” maps have been used to better manage and set recovery standards for the species. The “zone” maps were attached to various regulatory needs and help guide urbanization away from sensitive areas, allowing opportunities for purchase and protection of these karst areas by governmental and private organizations for species and drinking water protection.

As new information has become available, USFWS has updated their maps. The last update for the Austin area was made in 2006 and now NCKRI is contracted to update the map again. This new mapping is in progress and includes the use of powerful GIS statistical tools not previously available, which will assure the boundaries are as accurate as possible.

For more information about the endangered karst species and to see the current region and zone mapping, visit https://www.fws.gov/southwest/es/AustinTexas/ESA_Sp_KarstInverts.html#Karst_zones.



NCKRI Photo by George Veni.

Dr. Evelyn Mitchell (wearing the orange backpack) guides one her students in conducting a ground penetrating radar survey at Mission Concepción.

Karst With A Mission!

One of the fun but sometimes problematic things about karst is how it appears in surprising locations and in different ways. The US National Park Service contacted NCKRI in March 2019 about a sinkhole and potential subsidence problem possibly affecting the stability of Mission Concepción at San Antonio Missions National Park, a UNESCO World Heritage Site in Texas.

The park is on the south side of the City of San Antonio, which is not considered a karst area—or is it? NCKRI sent Dr. George Veni to investigate. He is from San Antonio and knew a broad apron of limestone gravel covers that area. It is partially cemented together and contains small karst features.

Additionally, Mission Concepción is located next to an ancient spring from the karstic Edwards Aquifer, which deposited a large fan of tufa. The tufa was quarried to build much of the mission in 1755.



NCKRI photo by George Veni.

The tufa is barely karstified, but contains many karst-like holes from how it was formed. Dr. Veni’s field investigation of a nearby construction trench revealed no gravel or tufa. Is the geologic map wrong for that area, or are they buried deeper?

Working with the National Park Service, NCKRI helped assemble a team of experts on the local geology, plus structural engineers, architects, and geophysicists for a second and more detailed evaluation in May 2019. Dr. Evelyn Mitchell of St. Mary’s University, who has worked with NCKRI on other projects, brought her ground penetrating radar equipment for an initial evaluation. Her results were helpful, but natural and artificial interference limited their interpretation, so many questions remain.

NCKRI will continue to work the National Park Service and other partners in the coming year to understand this potential karst area in order to preserve this internationally important cultural treasure.

Chinquipellobonus madlae is a blind and fully cave-adapted harvestman known only from caves in a small part of central Texas.

While not listed as endangered, it is related to some of the listed species. NCKRI’s updating of the USFWS karst endangered species maps will help keep this and other species from ever being listed.

Geophysics Duel in the Desert

What is the best geophysical tool to use to study karst? Geophysicists know that the answer depends on many different local conditions, what you are trying to find, and its likely size and depth below the surface. Some comparative studies have been done, but few if any in semi-arid to arid gypsum karst. NCKRI participated in a study to begin to figure this out and more.

In June 2019, Dr. David Decker, of Southwest Geophysical Consulting, assembled a team to compare three geophysical techniques while evaluating the possible karstic origin of some of the playas in the Burton Flats area east of Carlsbad, New Mexico. Dr. Decker brought ground penetrating radar equipment, Dr. Barbara Luke of the University of Nevada-Las Vegas brought seismic refraction, and Dr. Lewis Land and Michael Jones of NCKRI brought electrical resistivity equipment.

The team spent one week working on a series of near-surface geophysical surveys of playas and gypsum caves. Their preliminary results suggest that two of the playas surveyed are formed in part by subsidence associated with subsurface dissolution of gypsum bedrock, as opposed to being simple basins carved out by wind erosion or other processes. The comparative analysis of the geophysical methods is currently in progress.



Photo courtesy of Dave Decker. **NCKRI's Lewis Land and Michael Jones help set up seismic refraction equipment provided by the University of Nevada-Las Vegas for the geophysical study of Burton Flats.**



Photo courtesy of Dave Decker. **NCKRI volunteer Dave Brumbaugh and Michael Jones at a small playa studied by three geophysical techniques.**



NCKRI photo by Michael Jones. **Drs. David Decker and Barbara Luke explore a short distance into Chalk Cave during their study of the Burton Flats karst.**

Karst Information Portal

The Karst Information Portal (www.karstportal.org) is a NCKRI project in partnership with the University of South Florida Libraries (USF), University of New Mexico, and the International Union of Speleology (UIS). It is designed to serve many functions, with its primary function at this time as a free, digital, open access, international library of all things related to caves and karst.

In August 2018, our friends at USF re-launched the Portal with upgraded software for a new public interface. This interface was designed after the team reviewed many academic library digital collection websites and chose features they found most useful, in addition to adding their own ideas. As the next phase to that redesign, in Spring 2019 several Portal users volunteered to conduct their own critical review of the functionality of the Portal. Their survey is nearly complete and its results will be used to improve the Portal further.

The UIS has continued its project to scan the 12 proceedings volumes of its International Congresses of Speleology that were

not available digitally, or even in paper form to most people. Those proceedings are now being posted on the UIS website and the Karst Information Portal. To date, 10 of the 12 proceedings sets have been posted, totaling thousands of pages of valuable information. NCKRI scanned the USA proceedings from 1981 and volunteers from around the world have scanned the rest of this massive and important collection of speleological knowledge.

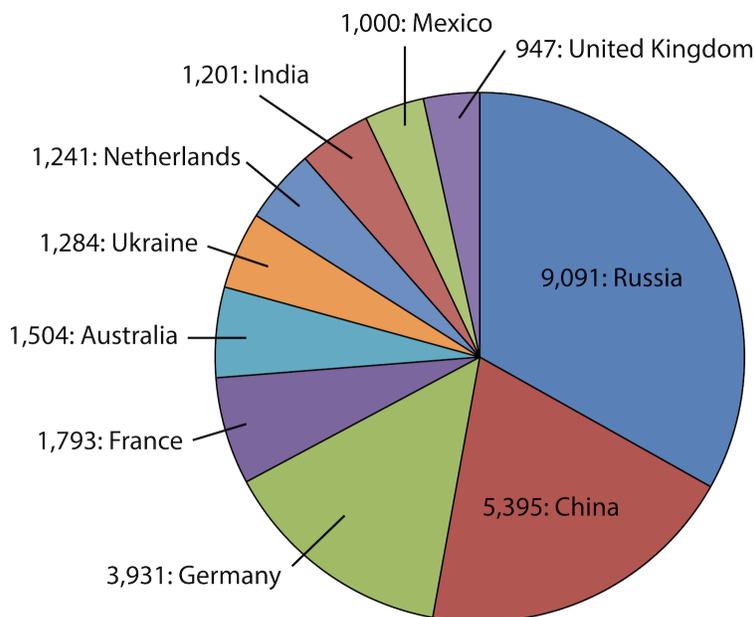
Additionally, more publications continue to arrive daily for posting on the Portal. NCKRI alone has submitted nearly 1,100 publications this year from reports around the world. Any organization that wishes to make its publications freely and internationally accessible through the Portal is encouraged to contact NCKRI.

Keep in mind that posting reports and other materials to the Karst Information Portal is not as simple as “cut and paste.” Hidden behind each posted item are codes and commands designed to make the materials as easily discoverable as possible through the Portal’s powerful search engine. However, the team at USF

is working to further automate and speed-up the new submissions workflow to catch up with the backlog of material as soon as possible.

The Karst Information Portal is monitored closely using the Google Search Console, Google Analytics, and other tools. They show great use of the Portal and increasing use around the world. During the past year, the Portal has had 183,358 downloads. Most are from the US but over 50 search engines have also discovered the Portal resulting in 41,867 downloads from 169 other countries! One of NCKRI’s major goals is to make cave and karst information as easily available as possible, and with the Karst Information Portal we are succeeding.

The Portal is now growing to the point of exceeding the storage capacity at USF. By the time this report is printed, the Portal will have re-launched using cloud storage. Other growth and improvements continue to occur, such as reports connected to GPS coordinates that will allow discovery of the reports through map searches of those areas. The coming year promises to be another good one.



This pie chart shows the number of reports downloaded from the Karst Information Portal from the 10 non-US countries with the most downloads during our 2018-2019 year.

National Cave Sample Archive

Last year NCKRI received a fabulous donation of 1,056 cave minerals from Dr. William B. White as the seeds for NCKRI's National Cave Sample Archive. The purpose of the archive is to collect and preserve any type of material from caves and karst and make them available to qualified scientists for study.

Thousands of samples have been collected from caves over the years and some are at risk of loss for lack of adequate or permanent storage facilities. Additionally, many caves are needlessly resampled for materials when specimens already exist but are not known to the greater scientific community. The National

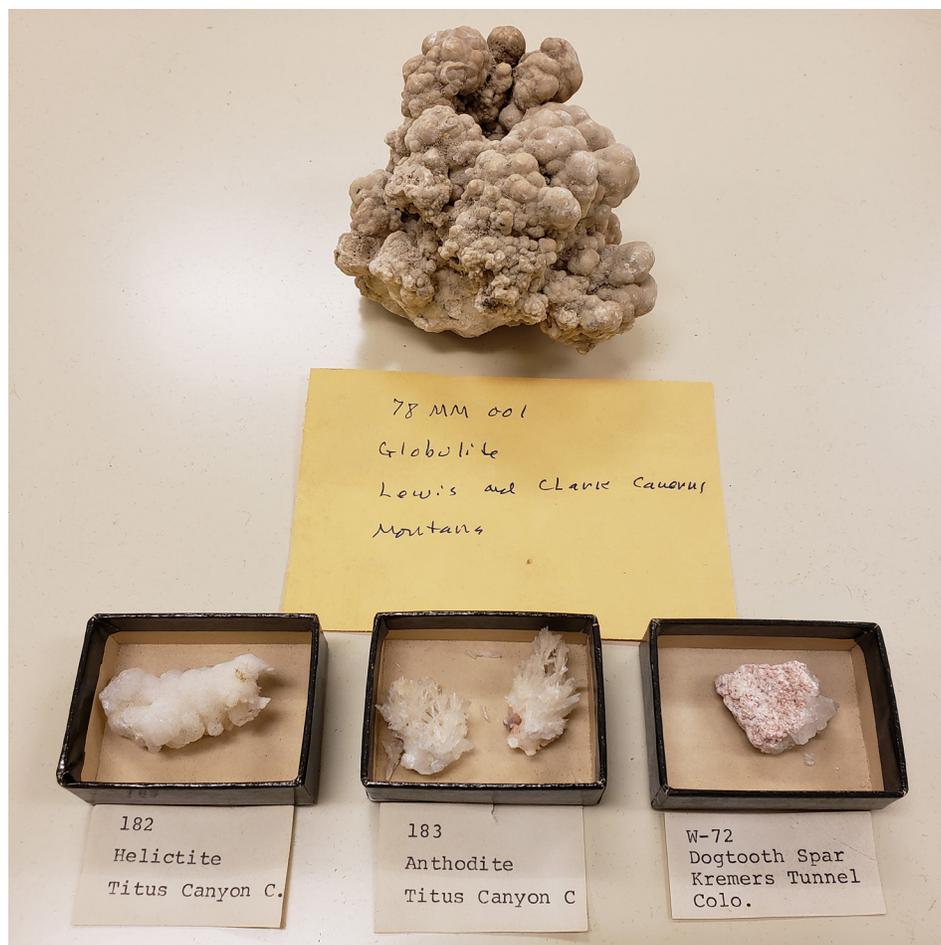
Cave Sample Archive will reduce and hopefully one day eliminate those problems.

During the past year, important but necessarily slow progress was made with the archive. First, Dr. White's donation included many specimens from several US national parks (collected with permission, of course!). It was necessary for NCKRI to first sort those out and see if the parks wanted their samples returned or kept at NCKRI. We did this with the help of National Park Service Senior Paleontologist Vince Santucci. Some specimens were returned but most remain in the NCKRI collection.

Second, we needed to move the collection from the temporary ship-

ping containers into proper archival storage cabinets. This needed to wait until tables, sinks, cabinets, a fume hood, and other substantial equipment were ordered and added to the NCKRI laboratory, which is happening as this report is being written. Look for updates in next year's annual report.

NCKRI is continuing discussion with other scientists who are considering preserving their materials with us. If you would like to talk with us about contributing cave samples to the archive, donating storage cabinets or supplies, or collaborating on this project in other ways, please contact Dr. George Veni at gveni@nckri.org or by calling 575-887-5517.



NCKRI photo by Michael Jones.

An example of the variety of cave minerals in NCKRI's National Cave Sample Archive donated by Dr. William White from caves around the world.

EDUCATION PROGRAM

This year has been another busy and exciting one for NCKRI's Education Program. We launched a huge effort for the Cave Exploratorium (our museum project) by focusing on exhibit development and local educational programming. We also conducted our usual variety of local to international educational workshops.

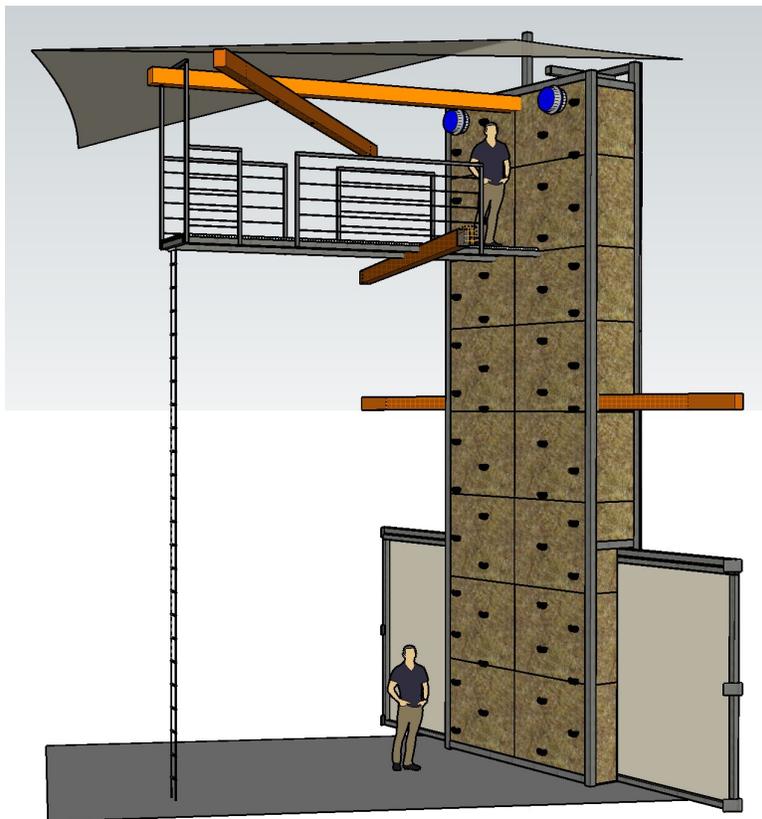
Drop Zone

The main project for the Cave Exploratorium is its Drop Zone experiential exhibit. The City of Carlsbad, in partnership with NCKRI, was originally awarded a grant to support the design and construction of this outdoor vertical classroom and exhibits. Dianne Joop, our Education Director,

expanded the exhibit funding by \$65,000 this year through grants.

This space will launch our Vertical Voyages program, which will provide the general public with authentic vertical experiences and unique learning challenges while also learning about caves and karst. The Drop Zone will also be used as a training site and practice area for people who use ropes and vertical work as a part of their jobs.

NCKRI held the initial design meeting to develop this exciting experience in 2016. This year NCKRI worked with its ropes course and exhibit designers to complete the design for this project. We expect construction to start soon. Please check out NCKRI's Facebook page for updates on this exciting project.



This artist's rendering shows a few of the many elements of the NCKRI Drop Zone. Designed to fit into the three-walled courtyard of NCKRI Headquarters (not shown), it includes a cable ladder climb, climbing wall, and beams for a variety of the climbing, rappelling, traversing, and other rope techniques. The opposite side of the climbing wall will display a stunning 9-m tall cave photograph.

Exhibits

NCKRI's Cave Exploratorium opened two temporary exhibits this year. In October 2018, in celebration of National Fossil Day, Dianne Joop curated a large exhibit titled *Cave Fossils*. This exhibition was made possible through a close collaboration with the National Park Service (NPS), particularly Senior Paleontologist Vince Santucci and the staff of Guadalupe Mountains National Park. It included a 3-m long display focusing on cave fossil resources within the NPS, a 13-panel interpretive display on cave fossils from around the world, and two rare cave fossils from the Smithsonian Institution.

Cave Fossils opened to the public with a National Fossil Day celebration. Over 500 people attended. Dianne Joop developed a fun-filled day of educational activities for elementary to high school students, who interacted with a variety of learning stations to learn different facets of cave paleontology and role-playing as cave paleontologists. If you would like to reserve the *Cave Fossils* exhibit for your space, contact Dianne at djoop@nckri.org.



NCKRI photo by Loren Darby
Potential future scientists study an extinct Pleistocene age musk ox skull in NCKRI's Cave Fossils exhibition. The skull is on loan from the Smithsonian Institution. It was discovered in the 1970s in a pool in Muskox Cave (Carlsbad Caverns National Park, New Mexico) where it was covered with calcite crystals. Many of the crystals were removed to study the bone, but still fill the eye sockets and sinus cavities.

In May 2019, the Cave Exploratorium opened the *Cave and Karst Landscapes Youth Poster Contest Gallery* exhibit. NCKRI partnered again with Guadalupe Mountains National Park, this time for the park's 4th Annual Poster Contest. Guadalupe Mountains National Park and NCKRI invited young artists through the US to participate in this year's contest with the theme of "Holey Landscape!"

NCKRI developed educational curriculum and in partnership with the NPS, kicked off this project by offering educational workshops and classroom visits in New Mexico and Texas. There were 250 entries from all over the United States, which were judged in a live event with over 200 audience members viewing. The *Cave and Karst Landscapes Youth Poster Contest Gallery* exhibit will remain open until the Fall of 2019.

Local Workshops

This year Education Director Dianne Joop continued her series of mini-workshops for interpretation professionals for the docents at New Mexico's Living Desert State Park. Through these workshops, participants learned about geologic history, cave and karst geology, and bats. She also taught students of different ages at Carlsbad's Jefferson Montessori Academy about caves and karst landscapes.



NCKRI Photo by George Veni.
Rain turns the fascinatingly unusual karst of China's Red Stone Forest of Xiangxi Geopark mostly black due to a thin biofilm coating. See the back cover for a different karst setting in Xiangxi Geopark.



Photo courtesy of National Park Service/Elizabeth Jackson.
NCKRI Education Director Dianne Joop leading Jefferson Montessori Academy students in a lesson on caves and karst landscapes.



NCKRI photo by Dianne Joop.
Over 200 children and their teachers from regional schools filled NCKRI's Exhibit Hall to see the Cave and Karst Landscapes Poster Contest Gallery.

International Workshops

In November 2018, China's International Research Center on Karst (IRCK) celebrated its 10th annual International Karst Training Course. The IRCK generously funds the participation of students and professionals from around the world, as well as lectures from an array of international experts. This year the Guilin-based course was preceded by an extensive field trip, which included the Dehang Grand Canyon and Red Stone Forest in Xiangxi Geopark, Hunan Province.

Dr. George Veni was again invited as an instructor for the training course where he taught, *The Impacts and Management of Climate Change on Karst Hydrology and Ecosystems*, and gave several formal and informal guest lectures.

Thank You!

NCKRI sends a huge "Thank You" to all who contributed to NCKRI's Education Program. To learn how you can support NCKRI's Education Program, please visit www.nckri.org/education.

NCKRI PARTNERS AND FRIENDS

Membership

NCKRI's Annual Membership program is offered to all interested persons wanting to support NCKRI activities. You can join online at www.nckri.org or call us at 575-887-5518. When you become a member, you will receive reduced rates on publications, special presentations, classes, lectures, and facility rentals, and in the future, discounts in the museum store.



NCKRI Partners

NCKRI recognizes four levels of partnership and uses their descriptions below in defining its relationships with NCKRI partners:

Founding Partners

NCKRI's Founding Partners played a crucial role in the creation of the Institute and continue to serve as major supporting partners. Each founding partner maintains one permanent position on NCKRI's Board.

- City of Carlsbad
- New Mexico Institute of Mining and Technology
- US National Park Service

Institutional Partners

Organizations with formally defined, mutually supportive relationships with NCKRI through Memoranda of Agreement, Memoranda of Understanding, contracts, or other written and signed agreements, in effect for periods of at least one year, and which define each party's specific roles and responsibilities.

- American Geosciences Institute
- Carlsbad Caverns National Park
- Emil Racovita Institute of Speleology (Romania)
- Guadalupe Mountains National Park
- International Research Center on Karst (China)
- Instituto do Carste (Brazil)
- International Academy of Karst Sciences
- International Union of Speleology

- Karst Research Institute
- New Mexico Bureau of Geology and Mineral Resources
- US Forest Service
- US Geological Survey
- University of New Mexico
- University of South Florida

NCKRI Affiliates

Organizations that demonstrate meaningful support for NCKRI and its goals, or their intent to do so, but without a formal defining agreement. NCKRI Affiliates are approved by the NCKRI, Inc., Board of Directors. NCKRI and its Affiliates exchange news and information, and coordinate and/or cooperate with each other in projects and activities. Each organization may also extend other benefits according to their internal rules and abilities.

- Bat Conservation International
- Carlsbad Chamber of Commerce
- Carlsbad Municipal Schools
- Edwards Aquifer Authority
- Fort Stanton Cave Study Project
- Karst Waters Institute
- Living Desert Zoo & Botanical Gardens State Park
- National Speleological Society
- NASA
- US Bureau of Land Management
- US Fish and Wildlife Service

Annual Giving

Our Annual Giving Program recognizes those individuals and organizations who joined as members or provided goods, services, and/or

financial gifts during FY 2018-2019 in support of NCKRI programs:

- Dr. Calvin Alexander
- Bert Ashbrook
- Representative Cathrynn Brown
- Carlsbad Foundation
- Richard Cervantes
- Melissa & Michael Cicherski
- Larry Cohen
- Jim Coke
- John Corcoran
- Paul & Sandra Cosand
- Jon Credit
- Annie & Philippe Crochet
- Guilhem De Grully
- Harvey Duchene
- Mayor Bob Forrest
- Markus Friedrich
- Mark & Nancy Hafkin
- Ken Harrington
- Larry & Signe Henderson
- Fernando Hernandez
- Internl. Research Center on Karst
- Megan Jones
- Dave Lester
- Matt Linville
- P.C. Lucas
- Frank Marks
- Jarell Myers
- Dr. Fadi Nader
- Pecos Valley Grotto
- Dr. Victor Polyak
- Paula Provencio
- Richard Raber
- Caden Sanchez
- Dr. George Veni
- Karen Veni/Night Cat Books
- Manfred "Dutch" von Ehrenfried
- John Wall
- James Wedekind
- Ján Zelinka

CONFERENCES AND MEETINGS

Rentals

Courtney Gasow, NCKRI's Event Planner, had to move from Carlsbad and leave NCKRI to attend to family needs. We miss her greatly. She established a huge record for rentals during this year, with nearly 10,000 people attending 156 rental functions at NCKRI.

We are frequently complimented for our beautiful and easy-to-use facility, which is why rentals have soared once Courtney better advertised NCKRI Headquarters' availability for private event rentals.

Our conference room can easily seat 150 people and is perfect for conferences, graduations, holiday and birthday parties, baby showers, luncheons, and public receptions and meetings. Our smaller board room is frequently used for week-long corporate meetings, business interviews, training workshops, and of course, board meetings. We also rent six cubicles with desks and lockable storage for those seeking temporary or long-term office space.

Funds collected through the rentals help us buy needed supplies and equipment to boost our programs. Ultimately, the rentals will give back to our visitors through a better understanding of caves and karst, and richer experiences learning about them.

If you need party, office or meeting space in Carlsbad, contact us at 575-887-5518 to learn about availability and all of our space and set-up options.

16th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst

"The Sinkhole Conference" series has internationally been among the most significant in creating a better understanding of karst processes that result in environmental problems, and finding solutions to those problems. It was placed under NCKRI's management in 2011. The next Sinkhole Conference will be held on April 20–24, 2020 in San Juan, Puerto Rico.

This will be the first Sinkhole conference outside of the mainland USA. The field trips will feature the

spectacular karst of the island. These will be the first trips for the conference series into tropical karst. The trips will include visits to a karst Superfund site and the giant Arecibo Radio Telescope—a tremendous engineering feat having been built deliberately in a giant sinkhole to cradle the enormous dish.

The conference will include four short courses in addition to the usual rich of array of oral and poster presentations from around the world. There will also be ample time to visit with colleagues. All breakfasts, lunches, and one dinner are included in the price of registration! To register and for all of the details and updates, visit <http://www.sinkholeconference.com/>.



NCKRI photo by George Veni.

The Arecibo Radio Telescope, supported by the floor and walls of a cockpit—a type of large sinkhole not found in the mainland US—will be visited during the upcoming Sinkhole Conference in Puerto Rico.

NCKRI Volunteers

Many of our programs and projects rely on the selfless help of our volunteers. We thank the following individuals for supporting NCKRI through their kind and inspirational efforts over the past year:

- David Brumbaugh
- Jeff Campbell
- Brianna Darby
- Courtney Gasow
- Brandon Hyer
- Mark Joop
- Erin Lynch
- Laurel McKenzie
- Logan McNatt
- Alex Nancarrow
- Larry Pardue
- Chris Person
- Katie Person
- Chris Petruccelli
- Merydith Turner
- Karen Veni
- Sidney Woods

STUDENT ACTIVITIES

Cave and Karst Studies at NMT

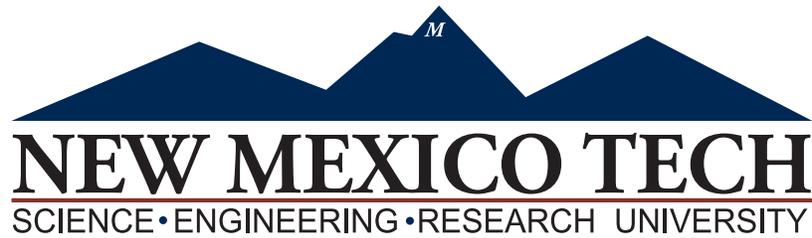
Cave and Karst Studies at New Mexico Tech (NMT) is NCKRI's Academic Program. It has been taught through NMT's Earth and Environmental Sciences Department for many years. However, for the past couple of years the Academic Director position was vacant until filled in January 2019 by NCKRI's new Academic Director, Dr. Daniel Jones.

This has been an exciting year for the Cave and Karst Studies program at NMT. During his 6 months at NMT/NCKRI, Dr. Jones got his lab up and running with two new students and projects in modern and ancient sulfidic cave systems. He also initiated a new undergraduate fellowship program to create research opportunities for NMT undergraduates, started a cave and karst seminar series, and hosted multiple lab visitors. Below are some details on NCKRI's Academic Program and the students and programs it is supporting.

Cave and Karst Research Fellowships for NMT Undergraduates

This year, we launched a new program for NMT undergraduates. The Undergraduate Research Opportunities in Caves and Karst ("UROCK") fellowship program is designed to create undergraduate research opportunities in cave and karst science at New Mexico Tech. Student awardees ("UROCK Fellows") receive a fellowship to work with a faculty member on a cave and karst research project during the academic year or over the summer. We awarded one UROCK fellowship in Spring 2019, and will announce additional awards for the fall.

Our first UROCK fellowship went to Jared Ciaro, who will work with Dr. Susan Bilek in the NMT Earth and Environmental Science Department on a geophysical charac-



terization study of a karst aquifer in Florida. The Santa Fe River Sink and Rise System in north central Florida presents a unique opportunity to study a large karst system remotely as the Santa Fe River flows underground for about 5 km from the sink to the rise.

Through a National Science Foundation supported project, Dr. Bilek's team deployed 14 seismometers and six tilt meters in 2018, in addition to a large number of hydrological sensors, in O'leno State Park. Mr. Ciaro and Dr. Bilek intend to use the geophysical data recorded by these instruments to characterize the subsurface flow path of the river, recharge into and discharge from the bedrock matrix, as well as significant changes to the system during recharge events.

Mr. Ciaro, an NMT undergraduate student and first UROCK awardee, has been assisting with data analysis and quality on this project, focusing on data from tiltmeters. Tiltmeters are sensitive to tilting of the ground in the nano- to microradian range. Thus, they can detect very subtle changes in the flexure of the Earth's crust induced by, for instance, water flooding into a cave system and pushing outward on the cave walls and ceiling. As these instruments are very sensitive, they also record tidal movements in the Earth and the soil's response to temperature changes. One of Mr. Ciaro's important tasks has been to remove temperature-induced tilting from the tilt data so he can work toward identifying and analyzing some of the signals related to the karst aquifer.



NCKRI photo by George Veni.
The Santa Fe River is a major component of the Floridan Aquifer system. During periods of low flow, algae often accumulates where the river sinks underground.

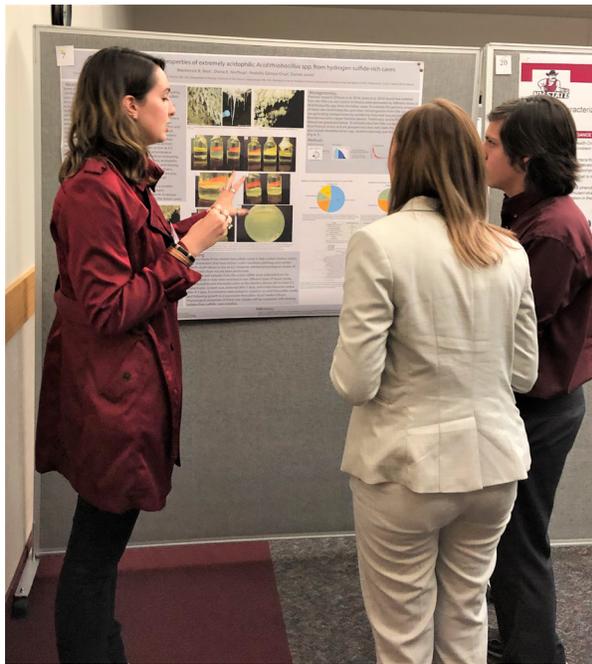
Student Research Projects

The hiring of Dr. Daniel Jones has been instrumental in attracting excellent students to and keeping them at NMT and NCKRI's *Cave and Karst Studies Program*.

Two examples this year are Mackenzie Best and Zoë Havlena, who presented their research at two conferences, the Rocky Mountain Geobiology Conference in Boulder, Colorado, and the Rio Grande Section Meeting of the American Society of Microbiology, which was hosted by NMT.

Ms. Havlena won 3rd place in the student poster competition at the Rocky Mountain Geobiology Conference. She also completed her Master's degree this year (see the following *Lighting and Lampenflora* report) and she is continuing at NMT for her PhD.

Dr. Jones welcomes students interested in any cave and karst topic to contact him and apply to study in his or other cave-related programs at NMT.



NCKRI photo by Dan Jones. **Mackenzie Best explains her poster on the study of acid-loving cave organisms to attendees of the American Society of Microbiology Rio Grande Section Meeting.**

Lighting and Lampenflora in Carlsbad Cavern

Caves used for tourism, called “show caves,” have many features that make them more accessible for the general public. Permanently installed lighting systems can be found in most show caves worldwide. While important for the visitor experience, the introduction of light into a naturally dark environment has negative consequences in the form of photosynthetic microbial growths called “lampenflora.” The green pigmentation associated with these biofilms not only detracts from the cave experience for visitors, but the growth itself damages the surfaces of cave walls and minerals—a process known as biodegradation.

The US National Park Service recently modernized the lighting in Carlsbad Cavern to an LED system that allows adjustment of color temperature and intensity. This change was an opportunity to see if changing the energy source for the lampenflora could be an avenue to reduce their growth.

To understand how such adjustments may reduce lampenflora, the park contracted NCKRI. Through our Academic Program, we started a two-phase student research study with the New Mexico Tech Biology Department under the supervision of Dr. Thomas Kieft. The study is conducted in close collaboration with Dr. George Veni at NCKRI and Rodney Horrocks,



NCKRI photo by George Veni. **Zoë Havlena measures light intensity and wavelength at a lampenflora sampling site in Carlsbad Cavern.**

Cave Specialist at Carlsbad Caverns.

The first phase funded a Master's thesis study by Zoë Havlena, who graduated with honors in May 2019. Using the easily adjustable new LED system, she designed an experiment to lower the color temperature of some lights to a range that should be less conducive to the photosynthetic growth of lampenflora, and measuring the growth in comparison to higher, more photosynthetically energy-rich levels provided by the historical lighting setup.

Lampenflora response to decreased color temperature output from the new LED system was monitored with a combination of spectrophotometric and qualitative observations, and changes in microbial composition investigated using high-throughput DNA sequencing. A hand-held reflected-light spectrophotometer was used to collect information on color changes, which was a non-destructive approach to assessing photosynthetic cell density. 16S and 18S rRNA gene amplicon sequencing provided taxonomic identities and microbial community composition data.

A diverse array of microorganisms were observed in the analysis of the sampling sites, although no significant difference in composition was seen to correspond to the

experimental variables of substrate, lighting, light intensity, or to time and the environmental conditions of temperature or humidity. The main photosynthetic organisms observed at the study sites were several types of green algae (*Chlorophyta*), another eukaryotic algal phylum called “golden-brown algae” (*Ochromytha*), as well as *Cyanobacteria*, which was the predominant photosynthetic phylum present at all sites.

The spectrophotometric data did not show the expected trend of increasing levels of growth over time or higher values for sites exposed to higher color temperature light. Greenness values obtained from the spectrophotometer did change over the study time period, and statistical significance between difference substrates was noted, however this trend was inconsistent.

Unexpectedly, cyanobacterial species, seen to dominate at the beginning of the study period at some sites, decreased in relative abundance while eukaryotic algae increased, particularly at sites that had no lampenflora present at the beginning of the study. Cyanobacterial presence also accounted for most of the observable variation in statistical analyses of the data, which suggests with the other results, that these organisms may play an important role in primary colonization of cave surfaces.

The study’s results suggest that the biofilm growths are more complex than previously thought, and that additional variables may be important to their proliferation. From a cave management perspective, the changes to the LED lighting do not seem to produce results consistent with an adequate reduction in lampenflora growth. Additional research would be beneficial to explore alternative methods to reducing this problem, potentially in areas that focus on preventing preliminary colonization of the cave and speleothem surfaces.

Chemical Treatment of Lampenflora From Carlsbad Cavern

The second phase of the lampenflora study for Carlsbad Caverns National Park is to find an effective means of removing lampenflora from caves and discouraging its regrowth. For decades, bleach solutions have been used by show caves worldwide to treat lampenflora, and for decades a better method has been desired that is less toxic and smelly.

Following an extensive review of the literature on chemicals and lampenflora, two chemicals were selected for testing: benzalkonium chloride (BKC) and hydrogen peroxide (H_2O_2). Since H_2O_2 alone is known to damage calcite crystals and cave wall surfaces, two H_2O_2 solutions are being tested. One is pre-saturated with calcium carbonate (the mineral that creates calcite and limestone), while the other has its pH adjusted to 7.5 with sodium hydroxide so it is not acidic.

Undergraduate student Isabelle (“Izzy”) Lakis worked on the project during the academic year, running a series of experiments to evaluate both chemicals on sets of calcium carbonate tiles (see below) and calcite crystals. Chemistry PhD candidate Eshani Hettiarachchi

has since worked on the project. The primary factors they measured are lampenflora growth on and erosion of the tiles and crystals. The initial results show promising results for BKC and the H_2O_2 solution pre-saturated with calcium carbonate, but notable chemical erosion from the pH-adjusted H_2O_2 solution.

It is too soon to predict the final results of these experiments. While some of the preliminary results are encouraging, more study is needed. Testing continues and the project is expected to be complete by next year.



NCKRI photo by George Veni. **Lampenflora can grow readily on moist cave sediments, as in Carlsbad Cavern where a probe measures airflow and temperature.**



○ Growing Lampenflora Colonies

Photo courtesy of Eshani Hettiarachchi. **These calcium carbonate tiles show initial traces of lampenflora as part of the experiment to chemically and more safely remove and prevent lampenflora growth in show caves.**

Groundwater Tracing and Cave Microorganisms: Are They Compatible?

Dye tracing, the placing of a non-toxic fluorescent dye into the ground to see where and when it arrives, is a long-standing and powerful tool for studying karst aquifers. But what is “non-toxic”?

Common fluorescent tracers have been tested for toxicity in multicellular organisms. Some dyes are government-approved for use in food, drugs, and cosmetics. But bacteria have been tested rarely. Might they be harmed?

This question concerns the US Bureau of Land Management (BLM). Fort Stanton Cave, New Mexico, contains the spectacular Snowy River Passage, which has a pristine microbial ecosystem. BLM wants to protect this ecosystem but recognizes that the source of water in Snowy River, while hypothesized, is presently unproven and unknown. BLM sees dye tracing as a potentially great tool to delineate the drainage area for the cave, but wonders if the dyes could harm the native

microbes.

NCKRI has an Assistance Agreement with the BLM for cave and karst research. BLM added funds to that agreement this year so NCKRI could investigate this dye-microbe question.

Most of the study is occurring through NMT student Evelyn Byrd under the guidance of Dr. Thomas Kieft. The project began in October 2018 when Dr. Lewis Land and caver Pete Lindsley led Ms. Byrd and NMT graduate student Eshani Hettiarachchi into Snowy River to collect microbial samples for testing from the water, sediment, and crystals found in the passage.

Ms. Byrd has since been evaluating the impact of four fluorescent dyes (uranine, eosin, sulforhodamine B, and pyranine), commonly used in karst groundwater research, on the growth of microorganisms from Snowy River. Growth was determined for isolated bacteria using spectrophotometry, direct cell counts, and agar diffusion experiments; overall metabolic activity was quantified by the rate of miner-

alization of ^{14}C -labeled glucose.

Spectrophotometry showed longer initial lag phases and diminished growth rates for the highest concentrations of each dye tested. These results were supported by direct cell counts. While no dye inhibited growth of a gram-negative organism on solid media, testing of a gram-positive organism showed that both uranine and eosin caused temporary inhibition while sulforhodamine B and pyranine did not. No clear change in overall metabolic activity at any concentration of uranine or eosin was seen.

Results so far suggest that only the highest dye concentrations (which would occur at the point of dye injection) inhibit microbial growth. The data do not indicate any one dye is less impactful than the others. However, further testing of the gram-positive organism may aid in this differentiation. Future work during the next year will also involve identifying the microbial isolates through 16S rRNA gene sequencing.

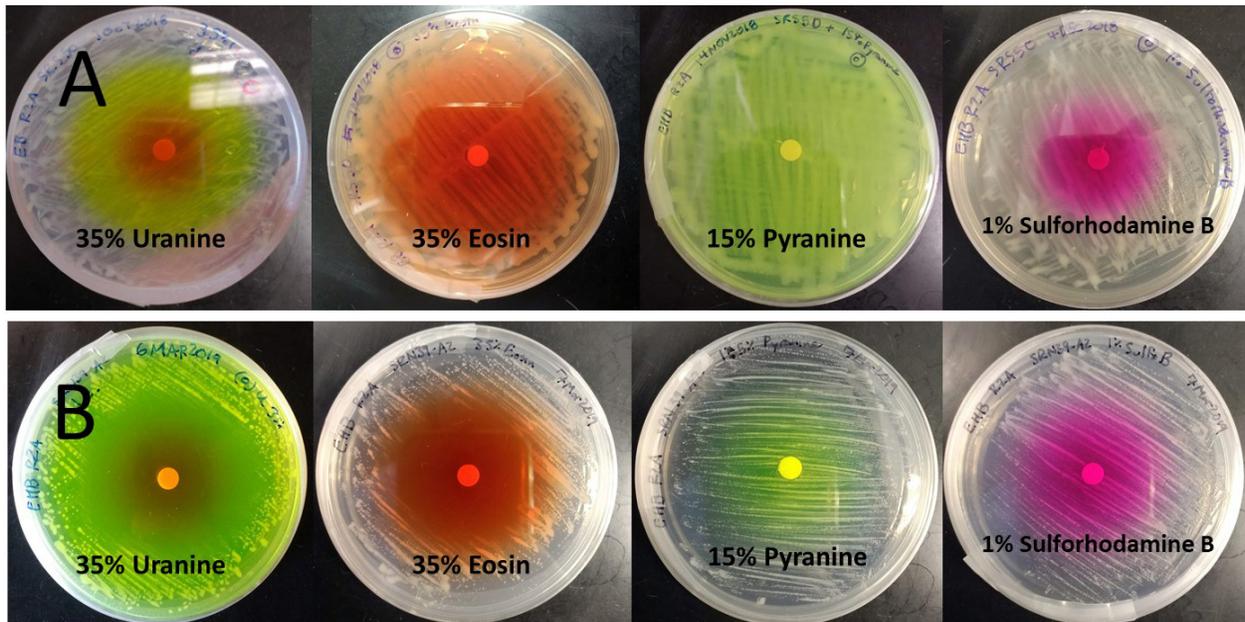


Photo courtesy of Evelyn Byrd.

Dye diffusion assays for highest dye concentrations of each dye. A) The gram-negative isolate was not inhibited by any dye tested. B) The gram-positive isolate was inhibited by uranine and eosin but not pyranine or sulforhodamine B. For all cases of inhibition, the organism eventually grew back over a period of several weeks.

NCKRI Seminar Series at NMT

Spring 2019 saw the kick-off for the “NCKRI Seminar Series,” part of the Earth and Environmental Science Departmental seminar series at NMT. Our inaugural speaker was Dr. Matt Covington, Associate Professor of Geosciences from the University of Arkansas, who gave the lecture, *What Controls the Rate of Weathering Within the Carbonate Critical Zone? The Answer is Blowing in the Wind*, on April 4th 2019.

Our second speaker, on June 25th 2019 was Dr. Muammar Mansor, a Postdoctoral Fellow from The University of Texas at El Paso, who presented *Strategies for Detecting Life on Mars and Interpreting Euxinic Events Throughout Earth’s History: Lessons from Sulfidic Caves*.

A great line-up of speakers is in development for next year, including by Dr. Jennifer Macalady from the Pennsylvania State University and Dr. Diana Northup from the University of New Mexico.

Cave and Karst Lab Colleagues

NCKRI has always believed that collaboration is critical to success, and that ethic continues in our reactivated and upgraded lab at NMT. Although less than 6 months old, we’ve hosted two colleagues and established our first international student exchange:

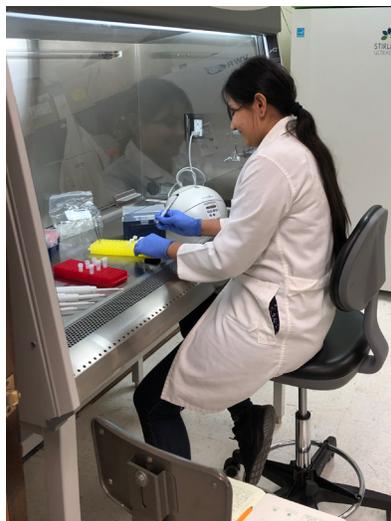
- Aspen Cooper visited to extract DNA from an archeological site at a karst rock shelter in Montenegro. This project is part of a collaboration with Dr. Gilliane Monnier in the Department of Anthropology at the University of Minnesota.
- Fátima Monserrat Retta Hernández was part of a collaboration with Dr. Rodolfo Gómez Cruz at Juarez Autonomous University of Tabasco, Mexico. She is focusing on Cueva de Villa Luz, a fascinating and globally significant cave.



NCKRI photo by George Veni.
Dr. Dan Jones (left) introduces Dr. Muammar Mansor (right) and his NCKRI Seminar lecture.



NCKRI photo by Dan Jones.
The NCKRI Seminars at NMT have been well attended and are open to anyone who wishes to attend. They have been followed by popular eclectic social gatherings of students, professors, and other friends over barbeque dinners.



NCKRI photo by Dan Jones.
Fátima Monserrat Retta Hernández working with samples from Cueva de Villa Luz, Tabasco, Mexico, in the NCKRI lab at NMT.

Student Support at Other Universities

While NCKRI is part of NMT, we regularly support students at universities around the world with information, as well as academic advisors. In addition to the usual informal assistance we provide frequently, this past year we continued to host Natasha Sekhon at NCKRI Headquarters and assisted with some of her field research. Ms. Sekhon is a PhD student from The University of Texas at Austin and was featured in our report last year for her geochemical research at Sitting Bull Falls, near Carlsbad. Additionally, Dr. Lewis Land assisted Dr. Kevin Stafford, a past NCKRI Scholar, and his graduate students from Stephen F. Austin University in tests of their electrical resistivity equipment.

OUTREACH

Professional Partnerships and Karst Standards

NCKRI values its partnerships with many organizations around the world, and the sincere friendships we've built with scores of their members. In addition to the projects and events with partners that we've highlighted elsewhere in this report, two related partnership projects stand out with China's International Research Center on Karst (IRCK) and ASTM International.

In 2018, China proposed to the International Organization for Standardization (ISO) the creation of a committee to standardize some karst research methods. The international member organizations of ISO approved the proposal, and the IYCK was charged with organizing the karst committee. NCKRI was asked for assistance in developing the committee agenda and other details, even though NCKRI couldn't participate directly in the committee, which is restricted to representatives of ISO member country organizations.

However, NCKRI is a member of another global standardization organization, ASTM International. At the June 2019 ASTM meeting, ASTM and NCKRI began organiz-



NCKRI photo by George Veni.

Standards exist for monitoring karst water wells, dye tracing, and other tools for studying and protecting karst areas. Can they be improved? How broadly can they be applied? These are a few of the considerations that will be evaluated by the ASTM and ISO karst committees.

ing a karst subcommittee that would work on a complimentary set of standards but could also represent the US in the ISO karst meetings. We are hopeful that the karst subcommittee will be established at the February 2020 ASTM meeting and that the US can be represented through NCKRI in the development of karst research standards with both international organizations.



NCKRI photo by George Veni.

What looks like only a farmer's field is the floor of Grassy Cove, the largest sinkhole in the USA. The skyline marks the edge of this sinkhole, which was visited during the Karst Hydrology Field Trip of the 2019 National Speleological Society Convention, held in Cookeville, Tennessee.

Professional Meetings

NCKRI again attended, sponsored and/or had a booth at many conferences during the past year:

- European Speleological Congress; Ebensee, Austria
- Mayors' Energy Summit; Carlsbad, New Mexico, USA
- International Show Caves Association Congress; Frasassi, Italy
- Geological Society of America Convention; Indianapolis, Indiana, USA
- Seminar on China-ASEAN Karst Hydrogeology and Environment Cooperation; Nanning, Guangxi, China
- 2nd International Seminar of Xiangxi Geopark; Jishou, Hunan, China
- China-ASEAN International Forum for Sustainable Development Innovation; Guilin, Guangxi, China
- 14th Mexican National Congress of Speleology; Hermosillo, Mexico
- Symposium on the Application of Geophysics to Engineering and Environmental Problems; Portland, Oregon, USA
- New Mexico Geological Society Spring Meeting; Socorro, New Mexico, USA
- Society of American Archeology Convention; Albuquerque, New Mexico, USA
- American Association of Petroleum Geologists Convention; San Antonio, Texas, USA
- ASTM International Conference; Denver, Colorado, USA
- National Speleological Society Convention; Cookeville, Tennessee, USA

NCKRI staff also organized or co-organized the following events:

- Field trip, *Exploring the origins of Austin Chalk cavernous porosity: implications for 3-D reservoir architecture within naturally*

fractured carbonate reservoir systems, American Association of Petroleum Geologists Convention, San Antonio, Texas, USA, 2019

- Session to create a National Speleological Society Committee on the International Year of Caves and Karst, National Speleological Society Convention, Cookeville, Tennessee, USA, 2019
- The 16th Multidisciplinary Conferences on Sinkholes and the Engineering and Environmental Impacts of Karst, to be held in San Juan, Puerto Rico, USA, in 2020

Guest Lectures by NCKRI

NCKRI staff were invited to give the following presentations and lectures.

Dianne Joop:

- *Effective Communications*. Leadership Eddy County, Carlsbad, New Mexico, USA
- *Non-Profit Leadership*. Leadership Eddy County, Carlsbad, New Mexico, USA
- *Tourism in Eddy County*. Leadership Eddy County, Carlsbad, New Mexico, USA

Dr. Lewis Land:

- *Hydrologic Investigation of Karstic Aquifers: San Solomon Springs Group, Far West Texas*. Edwards Aquifer Authority, San Antonio, Texas, USA
- *Karst Geology of the Santa Rosa Area and its Relation to Water Resources of the Upper Pecos River, New Mexico*. US Bureau of Reclamation Field Trip, Santa Rosa, New Mexico, USA
- *Use of Environmental Tracers in Evaluation of Groundwater Residence Time in Karstic Aquifers of the Southern Sacramento Mountains, New Mexico*. Albuquerque Geological Society, New Mexico, USA

Dr. George Veni:

- *Carlsbad Brine Well Cavity: September 2018 Status Report*. AARP Carlsbad Chapter, Carlsbad, New Mexico, USA

- *Cave Research in Mexico: a Proposal for Partnerships with the US National Cave and Karst Research Institute*. 14th National Mexican Congress of Speleology, Hermosillo, Sonora, Mexico
- *Exploring Karst—The Hidden Side of Planet Earth*. Associazione Culturale Sinopie, Rome, Italy
- *ISO Technical Committee on Karst – How ISO Standardization Could Impact Show Caves* (presented with Brad Wuest). 8th Congress of the International Show Caves Association, Frasassi, Italy
- *Karst—The Hidden Geography of Planet Earth*. The University of Texas at San Antonio Geography Society, Texas, USA
- *Major Concepts in Cave and Karst Management Strategies*. 2018 China-ASEAN International Forum on Sustainable Development and Innovation Cooperation and China (Guilin) High-Level International Forum on Health Tourism, Guilin, Guangxi, China
- *UIS Call to Action: the International Year of Caves and Karst*. 14th National Mexican Congress of Speleology, Hermosillo, Sonora, Mexico; 2019 National Speleological Society Convention, Cookeville, Tennessee, USA
- *Xiang Xi Geopark: Observations and Recommendations*. 2nd International Karst Symposium on Xiang Xi Geopark, Jishou, Hunan, China
- *We Are All the UIS*. 12th EuroSpeleo Forum, Ebensee, Austria



NCKRI photo by George Veni. **Cavers from the 14th National Mexican Congress of Speleology explore the lava cave, Tubo de Lava Cerro Blanco.**

Co-Sponsored Speakers

NCKRI co-sponsors the Edwards Aquifer Authority's Distinguished Lecture Series in San Antonio, Texas. In October 2018, Dr. Todd Halihan of Oklahoma State University gave the distinguished lecture on *A Voice for the Aquifers: What Carbonate Aquifers Have to Say*. He was followed in May 2019 by *Cave and Karst Interfaces: Rock, Water and Life*, presented by Dr. Annette Summers Engel of the University of Tennessee.

International Involvement

NCKRI is an Affiliated Organization of the International Union of Speleology (UIS) where Dr. George Veni is serving a four-year term as UIS President. The goals of NCKRI and UIS overlap, resulting in mutually supportive projects. Our longstanding joint project is with the Karst Information Portal, described earlier in this report. Our new collaboration is on the International Year of Caves and Karst (IYCK).

The IYCK is a UIS initiative to promote knowledge of caves and karst around the world in 2021 with the goal of increasing research, appreciation, appropriate management, and funding to support these aims globally. Thus far, the project has focused on coordination with the UIS member countries and dozens of supporting national and international organizations in tens of countries, coordination with the United Nations Educational, Scientific, and Cultural Organization (UNESCO), creating a leaflet, and building a website with all of the details on the IYCK.

NCKRI has contributed to these international efforts and next year will focus on its US-specific activities for the IYCK. Soon after this annual report is printed, the website will be posted at www.iyck2021.org.



NCKRI photo by George Veni.

Croatia's Plitvice Lakes National Park is an important karst World Heritage Site that is hoped to be the focus of some International Year of Caves and Karst activities.

Related to the IYCK, NCKRI staff serve on the United Nations' Non-Governmental Organizations Major Group and on the International Union for the Conservation of Nature's (IUCN) Geoheritage and Cave and Karst Specialist Groups. While caves are clearly an established priority for the IUCN, UIS and NCKRI have worked during the past couple of years to bring cave and karst issues to the United Nations for the first time.

As a different form of international outreach, UIS and NCKRI were involved with the rescue of the 13 boys of a soccer team and their coach from a flooded cave in Thailand, Tham Luang Nang Non. Our roles were admittedly modest, assisting in directing resources to Thailand and providing clear and knowledgeable information to the world media. We celebrate the rescue of the team, and mourn the loss of volunteer Thai Navy Seal diver Saman Gunan who died heroically during the rescue effort.

NCKRI also attended the congress of the International Show Caves Association (ISCA) for the first time, which was held at Frasassi Cave and ISCA headquarters in Genga, Italy, and began developing partnership possibilities with ISCA.

While in Italy, Ferdinando Di-donna generously arranged visits to

a couple of show caves and a public lecture by Dr. George Veni in Rome. He also set up a rare private tour of the Necropolis, the Roman cemetery now buried under Saint Peter's Basilica in Vatican City. Like show caves, lighting, lamphenflora, erosion, and other visitation impacts must be managed. We hope that coordination and data exchanges with Vatican archeologists may result in improved management methods for them and for caves.



NCKRI photo by George Veni.

An old narrow road of the Necropolis; doorways lead into individual Roman mausoleums.

National Involvement

- NCKRI is an Associated Society of the American Geosciences Institute (AGI) and the Geological Society of America and meets with those organizations regularly.
- Dianne Joop developed a cave educational piece for distribution around the country as part of AGI's Earth Science Week program.
- NCKRI has a position on the Steering Committee for the National Cave and Karst Management Symposium, which is held every two years. The next meeting will be in Bristol, Virginia, on October 7-11, 2019.
- NCKRI is an organizational member of the US Fish and Wildlife Service's White-nose Syndrome Stakeholder Committee.
- NCKRI's expertise was called upon by the Cibolo Preserve in Boerne, Texas, to advise on the hydrologic and ecologic implications of a newly opened cave that is swallowing the baseflow of Cibolo Creek.
- About the same time, NCKRI was called to advise on a karst spring and salamander investigation in the Balcones Canyonlands Preserve and National Wildlife Refuge located west of Austin, Texas.
- Board Member Dr. Calvin Alexander and Dr. Veni serve as advisors to the Karst Division of the Geological Society of America.
- Dr. George Veni completed his second three-year term, appointed by the Secretary of the US Department of the Interior, to serve on the Resource Advisory Council for the Bureau of Land Management's (BLM) Pecos District. The council normally meets 2-4 times a year to collect and analyze information, make field observations, hear public comments and develop recommendations for the BLM.

- Dr. Land reviewed the BLM’s Carlsbad Field Office (CFO) Draft Resource Management Plan. The plan intends to update natural resource and commercial development management strategies on federal lands overseen by the CFO. The planning area contains approximately one million acres of karst and has documented over a thousand karst features to date. The central challenge is to devise an overarching management strategy consistent with the BLM’s stated mission of multiple use and sustained yield, while minimizing the negative impact of commercial operations on the non-commercial resources on federal lands.
- Dr. Land participated in a field trip hosted by the US Bureau of Reclamation in the Santa Rosa, New Mexico, area focused on water resources of the upper Pecos River, and the impact of climate change on those resources. He gave an invited presentation describing the karst geology of the Santa Rosa area and its relation to water resources of the region.

Community Involvement

NCKRI is based in the City of Carlsbad, New Mexico. We are always excited to show support for this community that supports us so much, and to stay involved with the community in many ways. This year we were especially excited to participate in two major community events. The first was the Living Desert Zoo & Botanical Gardens State Park’s 25th Annual Earth Day Celebration, where we promoted our partnership with Guadalupe Mountains National Park’s Youth Poster Contest that had a cave and karst theme this year (see page 11).

We also participated for the first time at Carlsbad MainStreet’s annual CavernFest, which was attended



Photo courtesy of National Park Service/Elizabeth Jackson.

NCKRI Education Director Dianne Joop at our Earth Day booth where young people had fun learning about caves and karst.

by an estimated 8,000 people. We debuted our “Dress-Like-A-Caver” traveling exhibit and had many visitors. We thank Living Desert and Carlsbad MainStreet for hosting these wonderful events.

NCKRI hosts the monthly meetings of the Pecos Valley Grotto of the National Speleological Society



NCKRI photo by Michael Jones.

Rose Brumbaugh, daughter of Melissa Horn and Pecos Valley Grotto President Dave Brumbaugh, especially enjoyed NCKRI’s “Dress-Like-A-Caver” exhibit at CavernFest.

on the third Thursday of each month at 7 p.m. Anyone interested in cave exploration and research is welcome to attend.

NCKRI staff also:

- Participated in the Carlsbad Chamber of Commerce’s annual *Bat Brigade*. This delegation of community leaders visits leaders of New Mexico government at the state capitol to raise their awareness and support for issues in the City of Carlsbad and Eddy County.
- Regularly attended board meetings of the Carlsbad Department of Development and the Carlsbad Chamber of Commerce, and its Government Affairs, Education, and Tourism Committees, and participated in related activities supporting new businesses and community leaders.
- Served on the Creative Carlsbad Arts Council, and the planning committees for HeritageFest, Leadership Eddy County, Night of Lights, and the installation of the General Mahaffy Statue which was installed in the Cascades of Carlsbad development near the entrance of NCKRI Headquarters.
- Hosted a meeting of Creative Carlsbad at NCKRI Headquarters.
- Attended the meetings of the New Mexico Association of Museums Southeast Region and hosted a meeting at NCKRI Headquarters.
- Continued supporting the brine well cavity remediation by co-chairing the New Mexico Brine Well Authority’s Technical Committee and educating the public about the situation.
- Attended the Carlsbad Mayor’s Energy Summit, an annual event focused on the impact of the oil and gas industry in southeastern New Mexico, and for the first time, had an informational booth at the summit.

Media

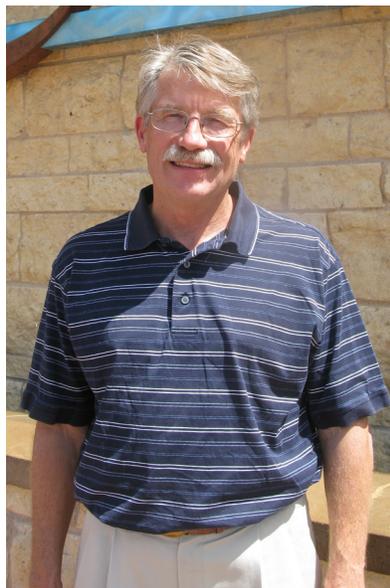
NCKRI staff were interviewed and featured in local to international print and video media this year, including:

- *Caves Celebrated as Natural Wonders and Repositories of History*. Lisa Isaacs, IOL News, 7 June 2019. <https://www.iol.co.za/capetimes/news/caves-celebrated-as-natural-wonders-and-repositories-of-history-25304608>
- *Cave Divers Prevail, as all 12 Boys and Soccer Coach are Brought to Safety*. Jeanna Bryner, Live Science, 10 July 2018. <https://www.livescience.com/63007-thai-cave-dive-rescue.html>
- *Cave Exploration Made Easier in New Mexico*. Adrian Hedden, Carlsbad Current-Argus, 19 February 2019, p. 1A, 3A. <https://www.currentargus.com/%2Fstory%2Fnews%2FLocal%2F2019%2F02%2F18%2Fnew-mexico-state-law-releases-landowners-liability-cavers%2F2905733002%2F>
- *Drilling Overwhelms Agency Protecting America's Lands: the Bureau of Land Management is Making it Easier to Produce Oil and Gas on Federal Acreage*. Rachel Leven, Center for Public Integrity, The Texas Tribune, The Associated Press, and Newsy, 13 November 2018. [https://www.texastribune.org/2018/11/13/new-mexico-drilling-oil-gas-overwhelms-agency-protecting-land/](https://apps.publicintegrity.org/blowout/us-oil-public-lands/)
- *Elon Musk's Plan to Rescue Trapped Thai boys? A Kiddie Submarine that Looks Like a Coffin*. Tia Ghose, Live Science, 9 July 2018. <https://www.livescience.com/63011-musk-minisubmarine-rescue-plan.html>
- *In Search Of, Season 1, Episode 6*. History Channel, aired 24 August 2018. <https://www.history.com/shows/in-search-of/season-1/episode-6>
- *Local Public Safety Divers Empathize with Daunting Thailand Cave Rescue*. Nick Powell, Houston Chronicle, 8 July 2018. https://www.houstonchronicle.com/news/houston-texas/houston/article/Local-public-safety-divers-empathize-with-13058517.php?utm_campaign=twitter-premium&utm_source=CMS%20Sharing%20Button&utm_medium=social
- *Mayor's Update: Happy Thanksgiving*. Dale Janway, Carlsbad Current-Argus, 25 November 2018, p. 5A. <https://www.currentargus.com/story/opinion/columnists/2018/11/25/mayors-update-happy-thanksgiving/2093477002/>
- *Mayor's Year-End Progress Report*. Dale Janway, Carlsbad Current-Argus, 30 December 2018, p. 5A. <https://www.currentargus.com/story/opinion/columnists/2018/12/30/mayors-progress-report-wrapping-up-2018/2422659002/>
- *NPS Looks to Mitigate Risk to Carlsbad Caverns*. Adrian Hedden, Carlsbad Current-Argus, 25 September 2018, p. 1A, 3A. <https://www.currentargus.com/story/news/local/2018/09/22/carlsbad-caverns-national-park-service-looks-mitigate-human-impact/1384443002/>
- *Officials Say Work on the Carlsbad Brine Well Will Begin in June*. Faith Egbuonu, KOB 4 News, Roswell, New Mexico, 23 April 2019. <https://www.kob.com/new-mexico-news/officials-say-work-on-the-carlsbad-brine-well-will-begin-in-june/5327510/?cat=500>
- *Reel South: A Texas Myth, Season 4, Episode 2*. PBS, aired 29 March to 14 July 2018. <https://www.pbs.org/video/a-texas-myth-q4eztb/?fbclid=IwAR1hoqBilqMdTvcnK7YxLV4Mcw8iLB6PAmtpDdtImAosOBVwexhzbwRHm5I>
- *The Very Real Risks of Rescuing the Boys Trapped in a Thai Cave*. Jeanna Bryner, Live Science, 6 July 2018. <https://www.livescience.com/63002-thai-cave-rescue-risks.html>



Gassel-Tropfsteinhöhle, is one of the fine caves in the mountains surrounding the 2018 EuroSpeleo, Ebensee, Austria. NCKRI photo by George Veni.

BOARD OF DIRECTORS CHAIRMAN'S REPORT



NCKRI photo by Debbie Herr.
Dr. Ronald T. Green, 2017-2019 NCKRI Board Chairman,

NCKRI was set in motion when the combined efforts of federal, state, and local politicians, academicians, and a healthy contingent from the cave and karst community were successful in the passage of the National Cave and Karst Research Institute Act of 1998.

The purposes of this Act were, and remain, to: (1) further the science of speleology; (2) centralize and standardize speleological information; (3) foster interdisciplinary cooperation in cave and karst research programs; (4) promote public education; (5) promote national and international cooperation in protecting the environment for the benefit of cave and karst landforms; and (6) promote and develop environmentally sound and sustainable resource management practices. Over time, a strong alliance of the National Park Service, New Mexico Tech, and the City of Carlsbad formed to establish the National Headquarters in Carlsbad, New Mexico, and staff it with a dedicated team of scientists and support personnel.

Unfortunately, the path since

the inception has been a challenge. For years the Institute subsisted on stagnant, even shrinking, funding. The toll on staff during these years was palpable. Staff positions were not filled, research programs were not funded and supported, and many day-to-day operations could only be marginally engaged. Happily, this trend was halted last year with increased funding from the National Park Service. Since that time, new staff positions were advertised and filled, and programs that support the NCKRI mission have taken on renewed activity and enthusiasm. The increased funding and support have greatly brightened the future of NCKRI.

The Board has taken steps to expand and strengthen its committee structure and activity. During the past year, committees on Research, Education, and Strategic Partnerships were formed and host both Board members and staff. They join the Executive, Budget, and Nominations committees, which have been active since the inception of NCKRI. There are high hopes these committees will help advance the NCKRI mission.

The Board and staff have been actively updating the NCKRI Strategic Plan for the past year. The Board met the Executive and Academic directors to identify the Goals and Objectives of the Institute. Since that time, members of the Board have been engaged with staff to identify action items and resources to achieve the goals and objectives of the Strategic Plan. It is hoped this important guiding document will mature with time and provide a clear path forward for staff and the Board.

I would like to thank fellow Board members Eddie David, David Lester and Bob Brinkmann, who recently cycled off the Board. I would like to offer special thanks to

Bob Brinkmann, who served as Vice Chair and two terms as Chair on the Board. Bob provided great vision and leadership as NCKRI transitioned from its early years to the more mature Institute it has grown to be.

I also would like to recognize two previous Board members, Dale Pate and Jack Hess, who served on the Nominations Committee with me for parts of eight years. During that time, we instituted a structured nominations and election process that included term limits for Board members and officers which I firmly believe serves the long-term interests of the Institute. We also diversified the Board to include members from a wider cross-section of the community than just the caving community. While caving remains central to the NCKRI mission, advancing the Institute will benefit from a broader and more diverse perspective from the Board. I would like to extend a warm welcome to our four newest Board members, Dave Williams, Bert Ashbrook, Andy Eavis and Dr. Katarina Kosic-Ficco. Dave, Bert, Andy and Katrina bring a wealth of diverse experience to the Board.

This being my last report as Board Chair, I would like to add two personal notes. First, it has been a distinct honor to serve as a member and the Chair of the Board of this national research institute. Second, I have the highest expectation the next Chair, Jack Swickard, will oversee great advances in the NCKRI mission. As I have previously noted and sincerely believe, the future of NCKRI is bright and the Institute will play an important role in serving the cave and karst interests of the nation in the years and decades ahead.

Sincerely,

Ronald Green, Ph.D., P.G.
Chair 2017-2019

NCKRI STAFF



NCKRI photo by Vicky Gonzales.

NCKRI's Carlsbad staff (left-to-right): Michael Jones, Dr. George Veni, Loren Darby, Dr. Lewis Land, and Dianne Joop.

Introduction

The staffing at NCKRI is going through some substantial changes. Below we start with our existing staff members, who are in the above photo, followed by a listing of new employees, and then someone who had to leave us at the end of the year. Also, in the closing days of the year we asked Vicky Gonzales to join us as our Operations Division Director. She started in the new fiscal year, too late for this report, but will be introduced properly in our next annual report.

Dr. George Veni, Executive Director

Dr. Veni is an internationally recognized hydrogeologist specializing in caves and karst terrains. Prior to NCKRI, he owned and served as principal investigator of George Veni and Associates for more than 20 years.

Much of his work has been in Texas, but he has also conducted extensive karst research throughout the United States and in several other countries. He served as the Executive Secretary of the National Speleological Society's Section of Cave Geology and Geography for 11 years and President of the Texas Speleological Survey for 13 years. He was the Chairman of the 15th International Congress of Speleology. He served as a member of the governing board of the International Union of Speleology from 2002–2009, as the Union's Vice President of Administration from 2009–2017, and as President from 2017 to the present. He has served as a doctoral committee advisor for geological, geographical, and biological dissertations for multiple universities and taught karst geoscience courses as an adjunct professor for Western Kentucky Univer-

sity for 12 years. Three cave-dwelling species have been named in his honor. In 2019 he was included in the listing of notable "scientists in planetary cave and lava tube research" in the book, *From Cave Man to Cave Martian: Living in Caves on the Earth, Moon and Mars*, by Manfred "Dutch" von Ehrenfried. He has published and presented over 240 papers, including five books, on hydrogeology, biology, and environmental management in caves and karst terrains.

Ms. Dianne Joop, Education Director

Ms. Joop is an experienced educator in formal and informal techniques, with her focus on caves, karst, science, and math. Before transitioning into education, she spent nearly a decade in theatrical and television production with Kentucky

Educational Television, the state of Florida, and the Discovery Channel, among others. In 2001, Ms. Joop stepped on a submerged can in an underground stream and took a nasty fall, and declared at that moment to make a difference in the world's understanding of caves as important and vulnerable resources. She began teaching in a private school while working on her MA in science and history education at Union College. She joined the National Speleological Society and began assisting with and developing cave education programs. In 2006, Ms. Joop held an internship with the National Association of Geoscience Teachers pilot Geoscience Teacher in the Park program at Mammoth Cave National Park. In her spare time, while teaching science, math and theater full time for public and private schools, she assisted with cave and karst education programs with Union College Outdoors, the American Cave Conservation Association, and Western Kentucky University. Ms Joop is also a Certified Interpretive Trainer and Certified Interpretive Guide.

**Dr. Lewis Land,
Karst Hydrogeologist**

Dr. Lewis Land is NCKRI's Karst Hydrogeologist and the Institute's lead geophysical investigator. Dr. Land's research focuses on regional investigations of groundwater resources within the extensive karstic aquifers of southern New Mexico and west Texas, and on geophysical investigations of karst geohazards. Prior to his career as a hydrogeologist, Dr. Land spent eight years in the petroleum industry exploring for new oil reserves in the Mid-Continent and Rocky Mountain regions of the US, and offshore West Africa. He received his PhD at the University of North Carolina at Chapel Hill, where his doctoral research included submersible investigations of submarine sinkholes in the Straits of Florida. Before

coming to work for NCKRI in 2002, Lewis spent two years with the North Carolina Division of Water Resources conducting electromagnetic surveys of regional aquifer systems beneath the coastal plain of North Carolina.

**Loren Darby,
Office Manager**

Ms. Darby joined NCKRI as the Office Manager in 2016. She supervises and performs financial, administrative, and managerial work to support NCKRI's programs. Ms. Darby grew up in Carlsbad where she attended high school and college. She started her 20-year career in banking at Carlsbad National Bank while in high school participating in the Business Professionals of America program. In 1997, she moved to Grants, New Mexico, and started working at The First Bank of Grants which within one year became Wells Fargo Bank. During her 17 years at Wells Fargo she furthered her career in banking, moving up the ranks and became a Service Manager, a position she held for 15 years. While at Wells Fargo she was selected to participate in The Potential Leaders Program, which not only gave her the opportunity for a lot of training but to also learn a lot about herself. In the spring of 2014, Ms. Darby was offered a position with the State of New Mexico Department of Transportation as a Financial Specialist. She has received numerous awards for her excellent performance throughout her career. Ms. Darby has been very active in the community in Grants, New Mexico, where she chaired the American Cancer Society's Relay for Life for 15 years. In 2014 she was invited to Phoenix, Arizona to attend the American Cancer Society's Leadership Summit. Ms. Darby has also been a 4-H parent leader for over nine years. She chaperones and participates with the kids as often as possible and served on the Cooperative Extension Advisory Committee.

New Employees



**Dr. Daniel Jones
Academic Director**

Dr. Jones is a geomicrobiologist and biogeochemist specializing in microbial sulfur cycling and microbe-mineral interactions in cave systems. He has a PhD in Geosciences and Biogeochemistry from The Pennsylvania State University, and was a postdoctoral fellow in the Department of Earth Sciences at the University of Minnesota. Prior to his combined new position as Assistant Professor of Geobiology at New Mexico Tech and Academic Program Director for NCKRI, Dan served as the program coordinator for the MnDRIVE Environment initiative at the University of Minnesota, and was a research associate in the University of Minnesota BioTechnology Institute. He remains as affiliate graduate faculty in the Department of Earth Sciences at the University of Minnesota. Dr. Jones serves as the Secretary of the Karst Division of the Geological Society of America. In addition to his work on caves and karst, Dan has diverse research interests in the field of geomicrobiology, and he has studied microbial processes in acidic mine drainage, hydrocarbon seeps into deep marine sediments, and wetland ecosystems, many of which provide useful insights into karst processes. His international research is widely published and cited.



**Michael Jones
Cave and Karst Science
Specialist**

Michael Jones is a Water Resources Geographer and Geologist, who focuses on karst water management. Prior to joining NCKRI in April 2019, he spent two years with The Meadows Center for Water and the Environment at Texas State University, serving as Water Resources Specialist, where he provided support for The Meadows Center’s Watershed Services and Freshwater Research programs. During his time as a student at Texas State University in 2016, where he graduated that year with his Bachelor of Science degree, he was an Intern with the Edwards Aquifer Research and Data Center and worked as a Lab Services Assistant at the Freeman Aquatic Station. During the fall of 2016, he also worked as a Research Assistant with the Texas Stream Team citizen science water quality monitoring program. In 2012 and 2013, he served as a Measurement While Drilling and Logging While Drilling Engineer with Crescent Directional Drilling, based out of Houston, Texas. His research interests include speleogenesis and the physical, chemical, and biological processes operating within karst aquifers.



**Joel Despain
Cave and Karst
Management Scientist**

Joel Despain was hired at the end of June 2019 as the first Cave and Karst Management Scientist at NCKRI. He has a Masters of Science degree in Hydrology from Western Kentucky University (2006) and a Bachelors of Arts degree from the University of Missouri in Magazine Journalism (1985). Mr. Despain was the Cave Management Specialist for Sequoia and Kings Canyon National Parks from 1991 to 2012 and was the US Forest Service Cave Program Project Manager for the State of California from 2014 until 2019. This work led to the recognition of hundreds of undocumented caves in the parks and the discovery of dozens of new cave-adapted species. He helped to implement the Federal Cave Resources Protection Act and has completed site visits to more than 20 US National Park Service units and a dozen national forests. He has led or participated in more than 100 cave research and exploration expeditions in 22 US states and 15 countries with multiple visits to Malaysia (Borneo), Indonesia, China, the Philippines, Chile, Cuba, Haiti and Mexico, and in the US to Lechuguilla Cave, New

Mexico, Jewel Cave, South Dakota, Whigpistle Cave, Kentucky, and others. He is an adjunct professor for California State University Northridge (shown to the left teaching a caving skills class for the university) and Western Kentucky University, served on the Board of Directors for the Cave Research Foundation and the Western Cave Conservancy, and was head of the International Exploration Committee for the National Speleological Society for more than 20 years. He has authored or edited three books on caves including one on the caves of Sequoia and Kings Canyon National Parks and numerous professional papers and articles. His research interests are in cave geomorphology and cave and karst resource management.

Transitions



**Ms. Courtney Gasow,
Event Planner**

Ms. Gasow joined NCKRI in 2016 as its first Event Planner. She moved to Carlsbad in 2012 and worked on contract with the Carlsbad Department of Development organizing its national nuclear conference and various post conference meetings. Previously, Ms. Gasow lived in

Houston, Texas, where she worked as the event coordinator for an art gallery for three years specializing in modern masters. The majority of her 18 years of experience in event planning stems from working in administration and special projects for the SOSA Group, a major fine dining organization in Texas. From conception to build-out, Ms. Gasow was instrumental in opening the first fine dining restaurant ever in a major US ballpark (Minute Maid Park, Houston, Texas). She also opened and managed three other restaurants with a combined gross of \$10 million annually. Ms. Gasow attended Richmond College in London, United Kingdom, studying British history for two years, and also attended the University of Houston-Downtown with a focus on psychology. She finished her Bachelor's degree in Sociology/Psychology when family needs moved her back to Houston and away from NCKRI in June 2019. We thank Ms. Gasow for her exemplary service.

Continuing Education

NCKRI staff polish and expand their skills whenever possible. Formal training attended by staff members in the past year includes:

- *Developing and Revising an ASTM Standard Training*. Travis Murdock, ASTM International.
- *Excel Spreadsheet Applications*, online training, New Mexico State University.
- *Training on ASTM Online Tools*. Molly Lynyak and Krista Robbins, ASTM International.
- *Vertical Techniques Workshop*, 2019 National Speleological Society Convention.



Refereed Papers Conference Proceedings Papers

- Land, L. 2018. Hydrologic investigation of karstic aquifers: San Solomon Springs Group, far west Texas. Geological Society of America Convention, Indianapolis, Indiana, <https://gsa.confex.com/gsa/2018AM/webprogram/Paper323576.html>.
- Land, L. 2019. Sinkholes as transportation geohazards in mixed evaporite-siliciclastic bedrock, southeastern New Mexico. New Mexico Geological Society spring meeting.
- Land, L. 2019. Sinkholes as transportation geohazards in mixed evaporite-siliciclastic bedrock, southeastern New Mexico. Symposium on the Application of Geophysics to Engineering and Environmental Problems, Portland, Oregon.
- Veni, G. 2018. Hypogene processes in the evolution of the karstic Edwards Plateau Aquifer, Texas. Geological Society of America Convention, Indianapolis, Indiana, <https://gsa.confex.com/gsa/2018AM/webprogram/Paper320194.html>.

Books and Book Chapters

- Veni, G. 2019. Rocks and water: cave and karst development at Government Canyon. In: *The Caves of Government Canyon*, Texas Speleological Survey Bulletin No. 7, pp. 9–27,

Journal Papers

- Land, L., Rinehart, A. 2018. Geophysical surveys of a potentially extensive cave system, Guadalupe Mountains, New Mexico USA. *Journal of Cave and Karst Studies* 80 (3): 109–120.

STAFF PUBLICATIONS

Unrefereed Papers

- Havlena, Z., Kieft, T., Veni, G., Horrocks R., and Jones, D.S. 2019. Preventing problematic photosynthesis in caves: do lighting methods and substrate affect the development of destructive lampenflora in Carlsbad Cavern? New Mexico Tech Student Research Symposium, Socorro, New Mexico; American Society for Microbiology, Rio Grande Branch Meeting, Socorro, New Mexico.
- Lakis, I.M., Kieft, T., Havlena, Z., Veni, G. 2019. Mitigation of lampenflora-based environmental biofilms in Carlsbad Caverns National Park. New Mexico Tech Student Research Symposium, Socorro, New Mexico.
- Veni, G. 2018. The International Union of Speleology and the International Year of Caves and Karst. 12th EuroSpeleo Forum, 2018, Proceedings of the 12th EuroSpeleo Forum, Ebensee, Austria, p. 26–27.
- Veni, G. 2018. UIS: Goals, projects, and common interests with ISCA. 8th Congress of the International Show Caves Association, Frasassi, Italy.
- Veni, G. 2019. Steps for characterizing the aquifer that flows from the San Solomon Springs. **Invited lecture**. Texas Parks and Wildlife Department Trans-Pecos Workgroup Symposium, Austin, Texas.
- Veni, G., and Cooper, J. 2019. Exploring the origins of Austin Chalk cavernous porosity: implications for 3-D reservoir architecture within naturally fractured carbonate reservoir systems. Field trip guidebook for the American Association of Petroleum Geologists Convention and Exhibition, San Antonio, Texas, 33 p.

2018-2019 STATE AND FEDERAL BUDGET



Fiscal Year 2019, Year-to-Date Summarized Financials as of June 30, 2019

Revenue		FY2019 Budget	YTD Actual	Balance Budget to Actual
State of New Mexico		\$ 361,771	\$ 361,771	\$ -
	Carryforward	\$ 325,687	\$ 325,687	\$ -
National Park Service		\$ 797,000	\$ 375,366	\$ 421,634
Grants & Contracts		\$ 570,869	\$ 77,661	\$ 493,208
Expenses		FY2019 Budget	YTD Actual	Balance Budget to Actual
State of New Mexico				
	Personnel	\$ 284,825	\$ 193,102	\$ 91,723
	Rent/Utilities	\$ 50,996	\$ 48,786	\$ 2,210
	Travel	\$ 2,500	\$ 45,314	\$ (42,814)
	Supplies & Other	\$ 23,450	\$ 85,822	\$ (62,372)
	Overhead	\$ 10,000	\$ 10,000	\$ -
	Subtotal	\$ 371,771	\$ 383,024	\$ (11,253)
			Carryforward	\$ 314,435
National Park Service				
	Personnel	\$ 557,772	\$ 326,511	\$ 231,261
	Rent/Utilities	\$ 29,500	\$ 19,501	\$ 9,999
	Travel	\$ 9,572	\$ 2,584	\$ 6,988
	Scholarships/Grants	\$ 100,000	\$ -	\$ 100,000
	Supplies & Other	\$ 28,268	\$ 28,648	\$ (380)
	Overhead	\$ 71,888	\$ 39,791	\$ 32,097
	Subtotal	\$ 797,000	\$ 90,524	\$ 379,965
Contracts & Grants				
	Personnel	\$ 215,201	\$ 44,915	\$ 170,286
	Rent/Utilities	\$ -	\$ -	\$ -
	Travel	\$ 89,927	\$ 2,816	\$ 87,111
	Supplies & Other	\$ 140,467	\$ 5,268	\$ 135,199
	Overhead	\$ 60,023	\$ 23,372	\$ 36,651
	Subtotal	\$ 505,618	\$ 31,456	\$ 429,247



National Cave and Karst Research Institute

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