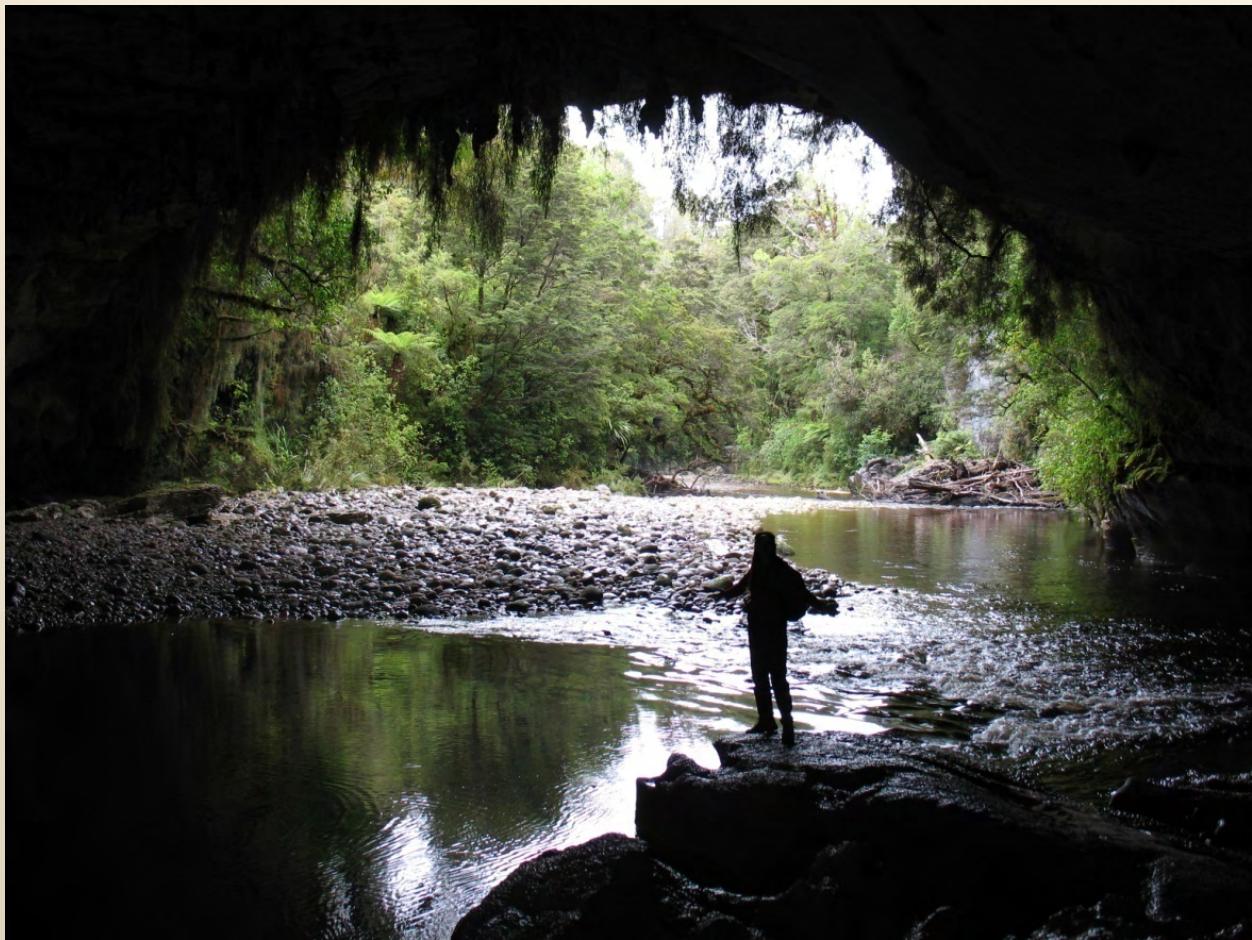




National Cave and Karst
Research Institute

www.nckri.org



ANNUAL REPORT 2007-2008

EXECUTIVE REPORT

The National Cave and Karst Research Institute (NCKRI) marks the close of its first full year as an independent, non-profit institute with this fiscal year 2007-2008 annual report. NCKRI was created by the U.S. Congress in 1998 as a federal entity, located in the City of Carlsbad, New Mexico, under the auspices of the U.S. National Park Service 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,

In 2006, NCKRI was changed to a non-profit corporation, operated through the New Mexico Institute of Mining and Technology (New Mexico Tech or NMT), to maximize its flexibility to enter into partnerships with other entities, raise funds, and respond quickly to new opportunities. NCKRI is actually now a hybrid non-profit through its status as an independent corporation while maintaining its Congressional mandates, obligations, and funding. The National Park Service now transfers annual federal appropriations to NMT on behalf of NCKRI. Additionally, NCKRI has maintained its key initial partnerships, the federal government through the National Park Service, the State of New Mexico through New Mexico Tech, and the City of Carlsbad. Each partner has a permanent position on the NCKRI board and actively participates in NCKRI activities as a formula for success.

This report summarizes NCKRI's activities from July 2007 through June 2008. It is designed and written to be read and enjoyed, as well as to inform. Publications lists from staff and students are included as guides to detailed reports on significant projects and activities. Despite the current low staffing of four full-time personnel, two part-time, and two part-time volunteers, productivity has been high. The following pages describe 14 notable staff projects and eight student research projects, which generated 26 research publications and conference reports. NCKRI staffed displays at a dozen national and international conferences, planting seeds for future partnerships and projects. Educational efforts included lectures, community outreach, and our first children's book.

Less featured in this report are the many tasks and long hours spent strengthening NCKRI's administrative foundation. Several documents and procedures were written or revised to reflect NCKRI's change into a non-profit corporation. A new logo was created. Our first Administrative Coordinator, Debbie Herr, was hired and is reducing years of backlogged document piles into orderly, readily-accessible paper and digital files. We have been working with the U.S. Congress to revise our enabling legislation and increase NCKRI's ability to work with federal agencies. Seemingly endless hours have been spent designing and refining architectural plans to begin construction of our headquarters. While less interesting to read about, these behind-the-scenes efforts are crucial to NCKRI's growth and continued success.

As I reflect on the past year's achievements, I'm both pleased and frustrated. The NCKRI team is productive, diverse, and strong. As can be seen in this report, there is a lot to be happy about. The frustration comes from thinking ahead to what NCKRI can be once its headquarters is finished and fully staffed. I'm ready for that now. There is so much work to do to meet our mandates. Still, I'm being patient and appreciate everyone's patience and support as we first set a strong foundation on which to build NCKRI's future.



G. Veni

George Veni, Ph.D.
Executive Director
National Cave and Karst Research Institute

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Cover photo: Moria Arch, a short, truncated cave in the Oparara River Basin of Kahurangi National Park, South Island, New Zealand. This photo celebrates one of NCKRI's major projects for 2007-2008, the Karst Information Portal (p. 8), having appeared on the cover of the Karst Information Portal brochure.

Contents page photo: Gouf le Balaa, Lebanon, dramatically illustrates the connection between surface and subsurface water in karst regions

Back cover photo: NCKRI hydrogeologist Dr. Lewis Land, Texas State University geologist Dr. Benjamin Schwartz, and NCKRI distinguished lecturer Marcus Gary examine caves in the Chosa Draw area, Eddy County, New Mexico; study area of NCKRI Scholar Dr. Kevin Stafford (p. 14).

Photos by George Veni.

NCKRI PROJECTS

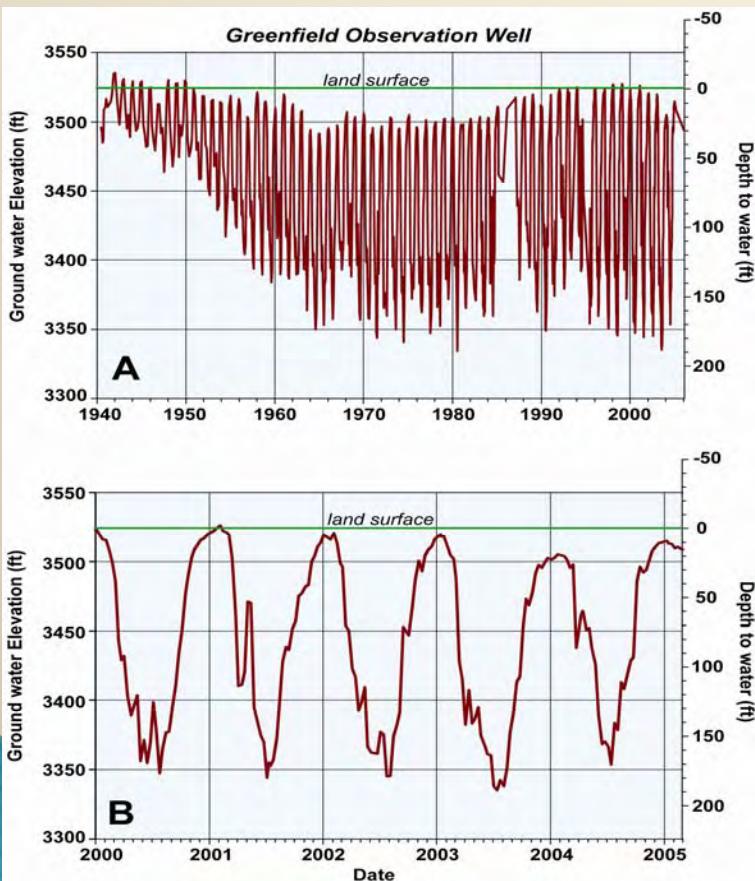
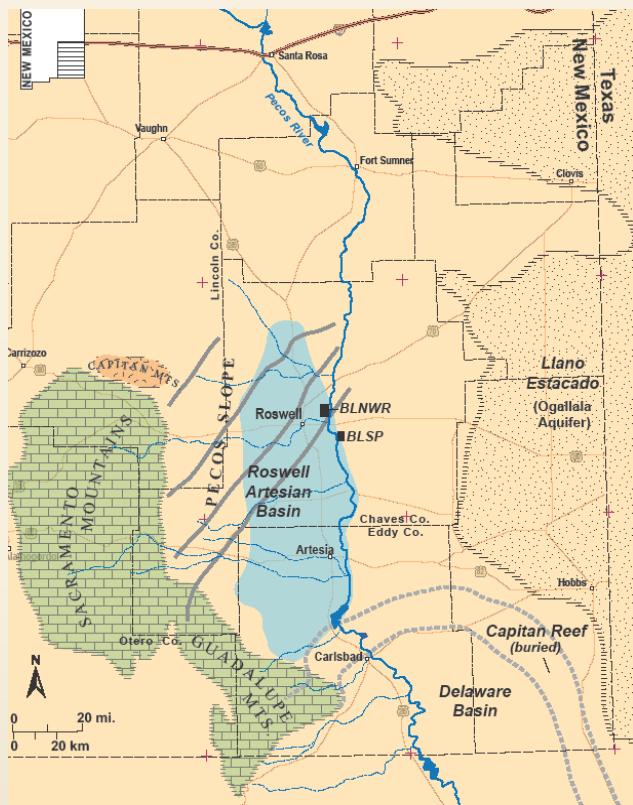
During 2007-2008, NCKRI spearheaded and participated in a diverse array of projects to help advance our scientific understanding of cave and karst resources, promote information sharing among scientists, educators, and the caving community, and advance cave and karst management. In doing so, NCKRI was engaged in a number of partnerships with federal, state, local, and university organizations. We are proud of these accomplishments and the foundation they have lain for NCKRI's future. A summary of these activities, and the key partners and staff involved, are described below and in the following pages.

Roswell Artesian Basin, Southeast New Mexico

Water levels in the karstic San Andres limestone aquifer of the Roswell Artesian Basin display significant changes on a variety of time scales. Large seasonal fluctuations are directly related to the irrigation cycle in the Artesian Basin, lower in summer months and higher in winter when less irrigation occurs. Longer-term variations are the result of both human and climatic factors. Since the start of irrigated farming more than a century ago, overuse of water resources caused water levels in the aquifer to fall by as much as 70 m. The general decline in water level began to reverse in the mid-1980s due to a variety of conservation measures, combined with a period of greater rainfall toward the end of the twentieth century.

Regional map of Roswell Artesian Basin, lower Pecos Valley, southeastern New Mexico.

*BLNWR = Bitter Lakes National Wildlife Refuge.
BLSP = Bottomless Lakes State Park.*



NCKRI hydrogeologist Dr. Lewis Land is the lead investigator for this project, which began in 2004. Talon Newton, hydrologist with the New Mexico Bureau of Geology and Mineral Resources, provided field and technical support. The Pecos Valley Artesian Conservancy District, an independent agency of the state of New Mexico, provided funding for this investigation. Results were published in the February 2008 issue of the Journal of the American Water Resources Association. An expanded report was published as a 2007 New Mexico Bureau of Geology and Mineral Resources Open File Report.

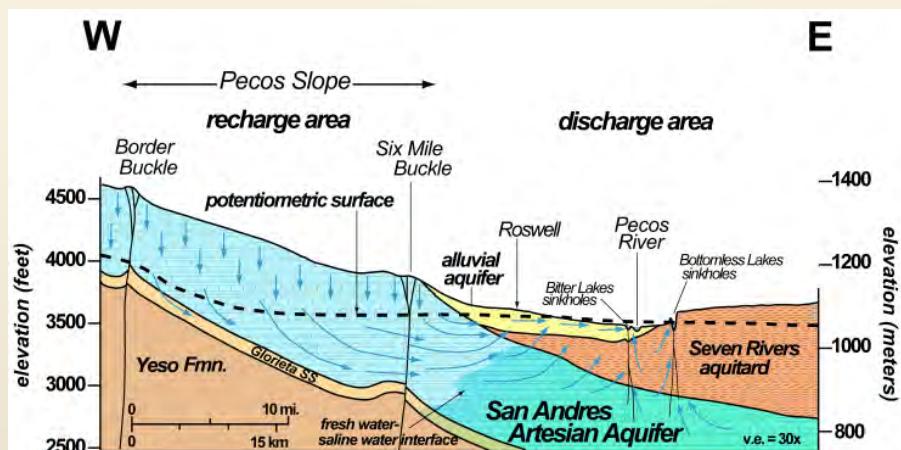
Bitter Lakes National Wildlife Refuge

Several natural and anthropogenic tracers were used to evaluate groundwater residence time within the San Andres limestone aquifer in the vicinity of Bitter Lakes National Wildlife Refuge (NWR). Natural groundwater discharge occurs from a region of karst springs, wetlands and sinkhole lakes at Bitter Lakes, located in the Pecos Valley east of Roswell, New Mexico. The springs and sinkholes are formed in gypsum bedrock, that serves as a leaky confining unit for an artesian aquifer in the underlying San Andres limestone, and are fed by upward seepage of groundwater from the aquifer (see figure below).

Wetlands on the Refuge provide habitat for a number of threatened and endangered species. Refuge managers are concerned about the potential for contamination from oil and gas drilling and other human activities in the aquifer recharge area. Estimates of the time required for groundwater, and hence contaminants, to travel through the aquifer vary widely because of uncertainties regarding the role that karst conduit flow plays in subsurface transport. A better understanding of groundwater residence time is thus required to make informed decisions about the management of water resources and wildlife habitat at Bitter Lakes.

Water samples were collected from nine karst springs and sinkholes and an artesian well located on the refuge, and analyzed for tritium, sulfur hexafluoride, chlorofluorocarbons, carbon-14, and stable isotopes of oxygen and deuterium. Results of these tracer investigations show that the artesian aquifer contains a significant component of water recharged within the last 20 to 50 years. Water discharging into the sinkhole lakes is probably a mixture of this older groundwater, some of which may indirectly come from older Paleozoic aquifers in the high Sacramento Mountains to the west, and groundwater of recent age whose volume has not yet been determined.

Cross-section of the Roswell Artesian Basin near Roswell, New Mexico, showing groundwater flow conditions in the shallow and artesian aquifers with respect to sinkholes at Bitter Lakes NWR and Bottomless Lakes State Park.



Dr. Lewis Land was lead investigator for this project, which began in 2004. Funding was provided by the U.S. Fish and Wildlife Service. Results of the study were presented at the 2007 annual meeting of the Geological Society of America. A paper documenting the results has been completed with co-author/investigator Dr. G. F. Huff, hydrologist with the Alberta Geological Survey, and will be submitted for publication in *Hydrogeology Journal*.



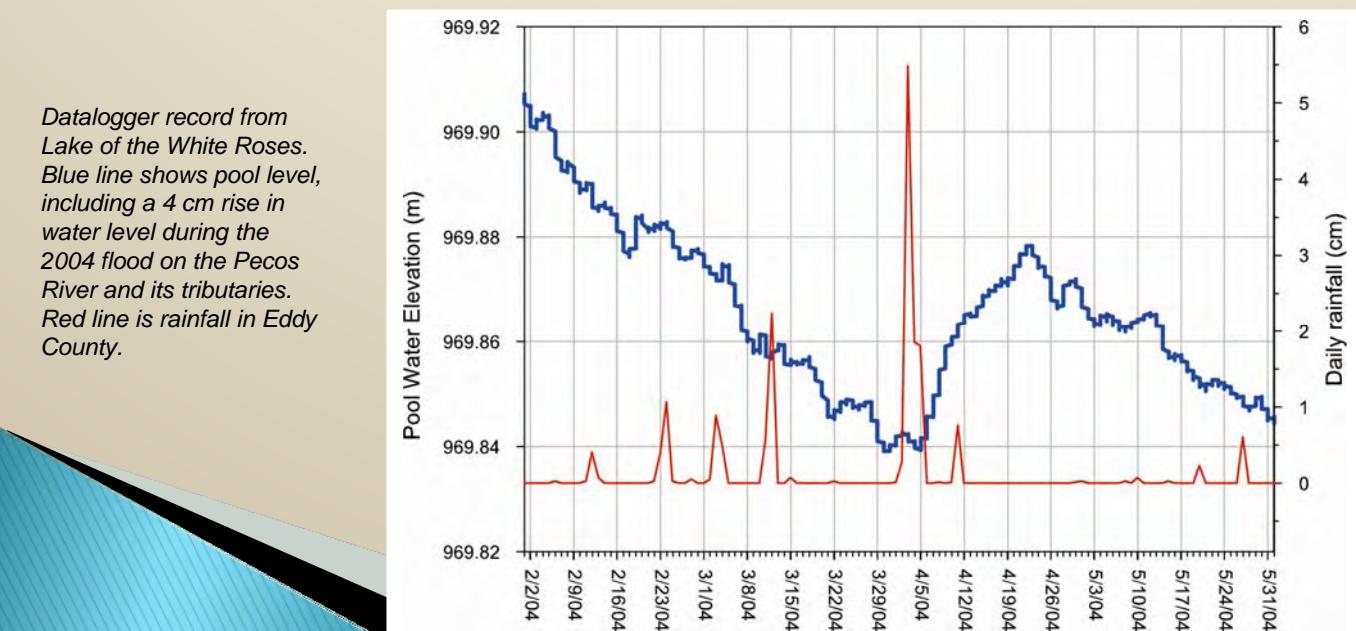
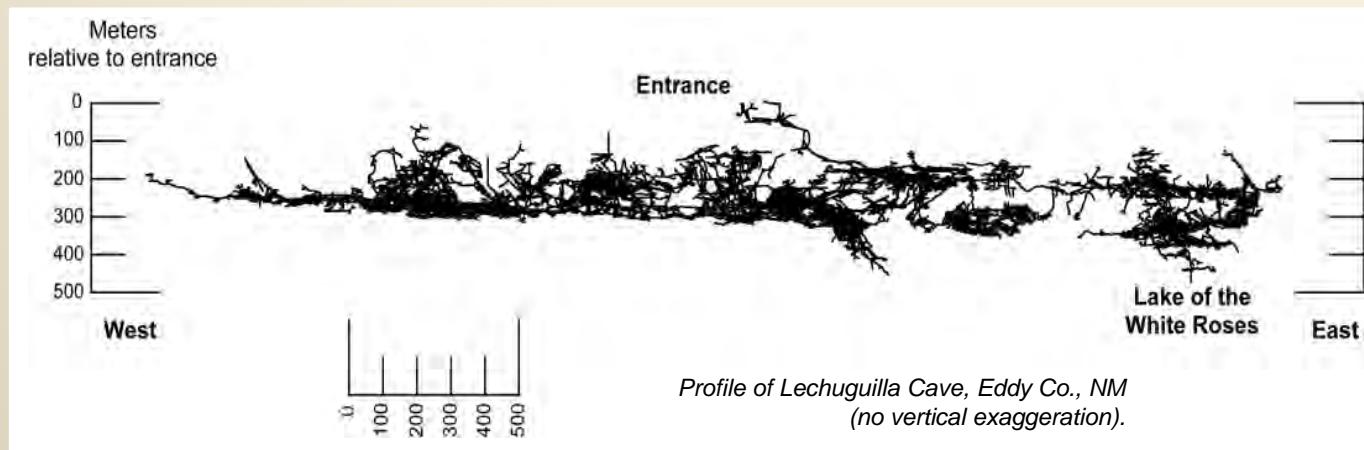
Collecting water samples from Sinkhole 59, Bitter Lakes NWR.
Phil Moyer is Dr. Land's dive partner.
Photo courtesy of Lewis Land

Groundwater Recharge and Discharge in the Capitan Reef Aquifer, New Mexico

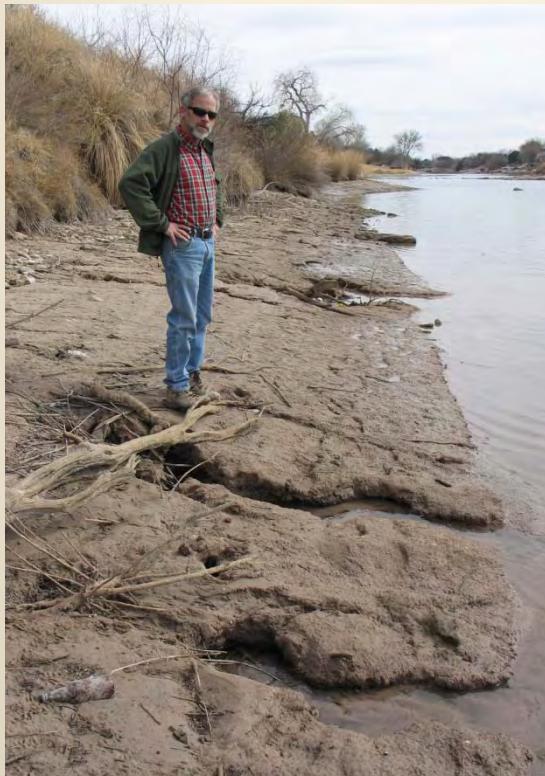
The Capitan Reef aquifer is the primary water supply for the City of Carlsbad and much of surrounding Eddy County. It is recharged in the Guadalupe Mountains of Texas and New Mexico, and its groundwater flows northeast to discharge from springs along the Pecos River in the City of Carlsbad. While its general hydrology is known, a detailed understanding of the aquifer is lacking. NCKRI has initiated the following preliminary studies, and plans more comprehensive research to fill that information gap. While the results will certainly prove valuable to the local communities, they will also help define groundwater behavior in hypogenic karst aquifers internationally.

Lechuguilla Cave, currently ranked as the deepest limestone cave in the continental United States, is formed in middle Permian limestone in the Guadalupe Mountains of southeastern New Mexico. A short-term rise in pool levels in the cave, in response to extreme precipitation and flash-flooding on the surface, demonstrated the connectivity between surface water, the cave, and the regional aquifer. Lake of the White Roses, the lowermost pool in the cave, is thought to intersect the water table of the Capitan Reef aquifer. Direct measurements and datalogger records show that pool levels had steadily declined more than 5 m since the pool was discovered in 1989, a period during which New Mexico was subject to episodic drought conditions.

In 2004, Eddy County experienced unusually high rainfall that included a severe storm in early April. This caused flash flooding in the Pecos River and arroyos in the Guadalupe Mountains, which serve as linear sources of recharge to the Capitan Reef aquifer. Within 3 days, pool levels in Lake of the White Roses began to rise, reversing a 15-year declining trend. Water levels in the pool eventually rose 4 cm above pre-flood conditions, then began to decline over the next two weeks. However, beginning in September, pool levels began to rise again, ultimately increasing by almost a meter relative to levels recorded at the beginning of 2004. The higher water levels persisted for several months, consistent with the longer-term precipitation record in Eddy County, which was twice the annual average in 2004. The short and medium-term increases in pool levels in Lechuguilla Cave also correlate to increases in water levels recorded in a monitoring well in the aquifer more than 32 km northeast of the cave, and appear to reflect the triple porosity system, conduit + fracture + matrix, that is typical of karstic aquifers.



In January 2008, the City of Carlsbad drained the lake along the Pecos River, created by the Upper Tansill Dam, to conduct normal maintenance along the shoreline. The lake inundates all but one of the springs that provide the baseflow to this section of the river. By draining the lake, the springs were exposed for direct sampling, which was conducted over three days at the end of the month. The purpose of the sampling was to collect baseline data on their chemistry and discharge to determine their individual sources and what level of groundwater mixing may be occurring from different sources. Currently, most of the water comes from the Capitan Reef aquifer. Water samples from two wells and three other springs in the area were also collected for comparison.



Dr. Lewis Land evaluating multiple small springs cutting channels into the mud along the lowered shoreline

The largest spring along the Pecos River in Carlsbad; photos by George Veni



Carlsbad Spring, before draining of the lake

Dozens of springs were discovered, many small and next to each other, and appeared to form possibly six distinct groups. Water samples were analyzed for major ions, nutrients, trace metals, and stable isotopes (^{18}O and deuterium). The lab results are being evaluated. One obvious result from field observations is that the Carlsbad Spring, the only spring not normally covered by the lake and often considered the “main spring,” is in fact not the largest spring. At least 2-3 times as much water was flowing from a spring about 100 m downstream on the river’s north bank.



NCKRI's Dr. Lewis Land provided the hydrologic interpretation for the Lechuguilla Cave study, based on water level data collected by Paul Burger, Park Hydrologist at Carlsbad Caverns National Park. The results have been accepted for publication in the proceedings volume of the Eleventh Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, a Geotechnical Special Publication of the American Society of Civil Engineers. An expanded report that includes documentation of a rapid recharge event in the San Andres limestone aquifer in the Roswell Artesian Basin has been published in the proceedings volume of a 2008 Karst Waters Institute conference in Rapid City, South Dakota.

The Carlsbad spring survey was initiated by NCKRI Executive Director and hydrogeologist Dr. George Veni and led by Dr. Land. Laboratory analyses were provided by the New Mexico Environment Department (NMED) in Albuquerque and Dr. Andrew Campbell's lab at New Mexico Tech in Socorro. Gary Schiffmiller, Environmental Scientist and Fisheries Biologist with NMED, was instrumental in the field sampling and coordination with the NMED lab.

Karst Information Portal

The Karst Information Portal (KIP) is an online source of digital research tools, databases, and collaborative workspaces (www.karstportal.org). It was designed to solve the problems of data access, management, and evaluation that challenge the progress of cave and karst science, stewardship, and education. KIP was created by a partnership of NCKRI, the Managing Organization promoting and organizing KIP activities, the University of South Florida, the Operating Organization in charge of the hardware and software which make KIP possible, the University of New Mexico, which develops and evaluates research and resource concepts for the KIP, and the International Union of Speleology, which conducts outreach to the worldwide speleological community.

The KIP has had a busy year. This corresponds closely to the first 12-month period following KIP's initial soft rollout; for that reason, a lot of the work we have done has occurred behind the scenes. However, despite its generally lower visibility, the progress made by KIP over this period positions us well for growth and expansion in the coming years.

One behind-the-scenes project is the KIP team's work to include more databases of raw data to make KIP a far stronger resource for many professional karst scientists. It is important for users to contribute to the growth of these databases by adding their own relevant data, or by updating the information already contained. However, without a quality control process, the quality of the databases could be severely degraded. Therefore, KIP has designed a process that enables users to both contribute to and update databases stored by KIP, while providing the original owner of the database some control over the exact nature of those changes. This quality control feature is essential in convincing researchers to allow their data to be made available in this manner. This process has been designed, and specifications for implementing it are now in the hands of KIP programmers.



*Dr. Alexander Klimchouk
(courtesy, A. Klimchouk)*

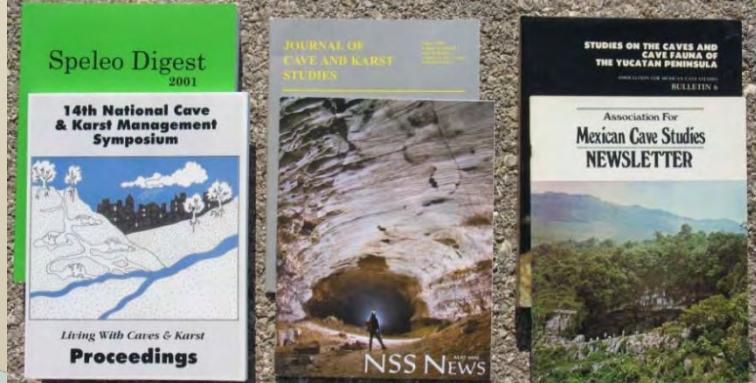
KIP staff have conducted and posted six oral histories with some of the leading names in karst science and cave exploration, including Dr. Derek Ford (Canada), Jeanne Gurnee (USA), Dr. William R. Halliday (USA), Dr. Alexander Klimchouk (Ukraine), Dr. Henry Schwartz (Canada), Dr. Elizabeth L. White (USA), and Dr. William B. White (USA). This project is ongoing, and we have targeted more interview subjects for the coming year. We feel that it is important to preserve the words, thoughts and voices of these individuals as their incredible careers may, in some cases (but by no means all), enter a less-active phase.

KIP, in conjunction with the National Speleological Society (NSS), has conducted a successful pilot project of digitizing back issues of the NSS News and adding them to the KIP catalog. This project will now be expanded to the entire history of the NSS News. KIP is now the sole source of NSS News issues in electronic format, thus expanding the reach of the NSS beyond its membership and to anyone with an interest in caves and karst, anywhere in the world.

Additionally, there are plans to digitize and upload back issues of NSS' SpeleoDigest and National Cave and Karst Management Symposium proceedings. Non-NSS journals have also been contacted regarding the possibility of going to an online, open access model, with KIP acting as host / publisher. One such cooperative venture is with the Association for Mexican Cave Studies (AMCS). KIP is now the only electronic, online source for publications from three of their series dating from 1965 to 1977.

University of South Florida graduate assistants, working as KIP staff, have continued expansion of the content catalog. New items are added every week, which makes for slow but steady growth of these vital materials. KIP staff are exploring the potential of including online geographic information systems (GIS) karst mapping capabilities in KIP. This action item is still in the research phase, as we have begun investigating the different infrastructure options available. Staff from NCKRI and the other KIP partner organizations have worked to raise awareness of KIP by publicizing it at several professional conferences via poster sessions and paper presentations in earth science, information science, and karst stewardship disciplines.

Some of the NSS and AMCS publications now available through the KIP



Carbonate Pool Precipitates

This project, supported by the National Science Foundation, studies the role of microbiological and geological processes in the creation of unique carbonate pool precipitates that appear to have a biological influence in their development, such as pool fingers, complex pool floor textures (e.g. "meringue"), u-loops, and webulites (gauzy-appearing connections between pool precipitates). Based on initial work published in 2000, this collaboration by NCKRI geomicrobiologist Dr. Penelope Boston, Dr. Leslie Melim (Western Illinois University), and Dr. Diana Northup (University of New Mexico) is investigating geochemical, microfossil, and other types of evidence to shed light on the development of such structures.

The World's Longest Cave Deposit

Snowy River is a cave pool deposit that extends for over 6 km in a passage discovered in Fort Stanton Cave, northern Sacramento Mountains, New Mexico. It has been described as probably the longest cave deposit known on earth. Hydrological, geological, and geomicrobiological study of the cave, and especially Snowy River, is a partnership of NCKRI with the Bureau of Land Management (BLM), Fort Stanton Cave Study Project, New Mexico Bureau of Geology and Mineral Resources, and the University of New Mexico.

Until recently, hydrogeologic investigations have been conducted at low levels due to a lack of funding to support systematic work. However, in late Summer 2007, during rare flooding of Snowy River, NCKRI funded Dr. Lewis Land to collect samples for stable isotope and geochemical analysis. The following year, BLM gave NCKRI permission to collect core samples from the Snowy River pool deposit. In May 2008, Dr. Land collected nine 2.54-cm diameter cores with a hand-held drill fitted with a water-cooled diamond bit. The cores show that the deposit is laminated. Each calcite lamina probably represents a distinct flooding event, thus the cores may provide valuable paleohydrologic and paleoclimatological information about that part of the southwest U.S. Thus far, one core has been sampled for stable isotopes of oxygen and carbon, and a layer near the base of the deposit has been dated by Dr. Victor Polyak, of the University of New Mexico, at ~810 years based on uranium-thorium methods.



Snowy River deposit, Fort Stanton Cave, Lincoln County, New Mexico; view south (upstream).



*Core from Snowy River pool deposit.
Photos submitted by Lewis Land.*

Dr. Penelope Boston, acting spokesperson for the Snowy River project, led senatorial and congressional staff into Snowy River to illustrate conservation issues bearing on the cave and its groundwater catchment basin, and on caves and karst in general. She also organized the first television filming of Snowy River, for broadcast on the Discovery

Channel's *Into the Unknown with Josh Bernstein* in late Fall 2008. A major proposal for BLM funding of extensive science and management activities is pending.



Dr. Land holding a core extracted from the Snowy River deposit.

Southern Sacramento Mountains Watershed Investigation, New Mexico

In 2006, the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) began conducting a multi-year investigation of groundwater residence time and recharge conditions in karstic aquifers of the southern Sacramento Mountains watershed. This region is the source area for a number of streams that recharge the karstic San Andres limestone aquifer in the Roswell Basin east of the mountains and the Salt Basin/Otero Mesa region to the south. This project is funded by the state of New Mexico through the Otero Soil and Water Conservation District, and may later be extended farther south to include investigations of groundwater resources beneath Otero Mesa. An interim progress report was recently published by NMBGMR and is available for free download at:

http://geoinfo.nmt.edu/geoscience/projects/sacramentos/SM_report_june08.pdf

*Bluff Spring, Otero County, New Mexico, in winter.
The spring discharges from a perched aquifer near the
contact of the San Andres and Yeso formations.
Photo by Lewis Land.*



NCKRI's contribution to this NMBGMR project is through Dr. Lewis Land's involvement in the application of environmental tracers to determine groundwater residence time. His collaborators at the Bureau include

Dr. Geoffrey Rawling, Talon Newton, Stacy Timmons, Peggy Johnson, Patrick Walsh,
Dr. Michael Timmons, Bonnie Frey, Brigitte Felix, and Dr. Trevor Kludt.

Iron-Manganese Deposits in Caves and Desert Varnish

This project by NCKRI's Dr. Penelope Boston at New Mexico Tech is in collaboration with biologist Dr. Diana Northup and mineralogist Dr. Michael Spilde, both of the University of New Mexico, and other colleagues including many students from both institutions. It has been funded by the National Science Foundation on several consecutive grants for eight years. They completed recent studies on the relationship between the types of metal-using microorganisms in a variety of caves and those that appear to contribute to surface rock coatings (desert varnish). Study sites include Lechuguilla Cave and Spider Cave in New Mexico, Jewel Cave in South Dakota, and desert varnish sites in California, Colorado, New Mexico, Utah, and the Atacama Desert, Chile. Work continues with the organisms isolated from these environments.

Naica Mine Cave Geomicrobes

A February 2008 *National Geographic* documentary film-shoot provided an opportunity to begin the study of possible microbial contents in fluid and solid inclusions within enormous selenite crystals in a geothermally active mine system in Chihuahua, Mexico. Nests of up to 5-m long crystals crowding limestone cave rooms, crystalline iron oxide wall deposits, and a working temperature of 60°C, combined to make a unique working environment. Italy's La Venta Caving Group and Dr. Paolo Forti from the University of Bologna, provided vital collaboration with their ice suits and valuable scientific contributions. Laboratory analysis of the fluid and solid inclusions continues at New Mexico Tech. The finished television documentary will be broadcast in late November 2008 on the National Geographic Channel.

Met Pro Corp. – Cave Microorganism Metabolic Capabilities

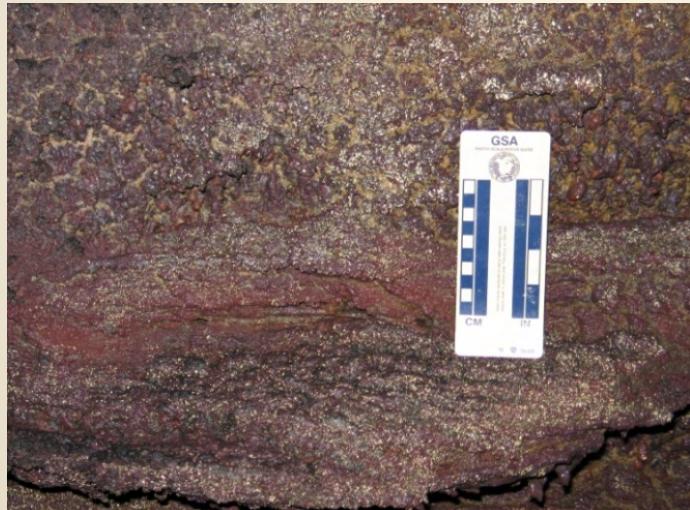
Prior work by NCKRI's team and colleagues has shown that cave microorganisms may possess many unusual metabolic and chemical properties that distinguish them from their surface counterparts. Industrial and pharmaceutical interest in these compounds and metabolic capabilities has been inhibited by the complexity of working with organisms taken often from federally managed lands. In a pilot effort, and in consultation with NPS solicitors, we have undertaken a screening program for microbial capabilities possibly possessed by some of our cave isolates and which interest our project sponsor, Met-Pro Corporation. If any of our organisms prove to have properties of interest to Met-Pro, this project will provide a perfect proof-of-concept for testing the new methods in place to enable commercial utilization of natural biological resources present in our federal lands.

At such a time, as Met-Pro expresses interest in developing any microbial capabilities, we will turn over the negotiations to the National Park Service, Bureau of Land Management, U.S. Forest Service, or other relevant agency.

Microbes, the Moon, Mars, and Beyond: NCKRI Projects on Extraterrestrial Caves and Life Forms

Five expeditions for the NASA Spaceward Bound Teacher Training Program have occurred since 2006 in an ongoing partnership with NASA Ames Research Center to provide extreme environment field science experiences for K-12 educators. The current report period encompasses expeditions to the Mojave Desert and Mt. Shasta, California. Dr. Penelope Boston is the team leader for cave, karst, lava tube, and microbiology activities. The March and June 2008 trips served 27 teachers and involved 25 scientists. The project continues into the coming year with more Mojave work, and expeditions to the Canadian Arctic and Flinders Ranges, Australia.

Dr. Penelope Boston leads NCKRI's research and educational work in geomicrobiology, with special emphasis on its extraterrestrial applications. Partners, sponsors, and colleagues include organizations, agencies, and scientists throughout the U.S.



Microbial colonies on the wall of a lava tube in the Republic of Korea. Photo by George Veni.

For the past 15 years, NCKRI's Dr. Penelope Boston and University of New Mexico colleagues Dr. Diana Northup, Dr. Michael Spilde, and others have been pursuing studies on the geomicrobial inhabitants of lava tubes as surrogates for possible microbial habitats on the Moon and Mars. In 2007 and 2008, subprojects in Hawaii, the Azores, Mexico, and Oregon were added to the ongoing work in New Mexico and California. The primary research focus is characterization of the microbial communities present and the roles they may be playing in secondary mineral deposits in lava tubes. In addition, following on NASA-funded projects from 2001 through 2006, with partners at MIT and TechShot, Inc., work continues on the role of extraterrestrial lava tubes (the Moon and Mars) in future space exploration. A partly NCKRI-sponsored workshop on these issues will be held in Fall of 2008 to assess lava tube studies vis-a-vis NASA's goals.

In June 2008, NASA funded a project to develop and field-test a point spectrometer based on acousto-optic tunable filter technology to detect biological signatures in samples collected during planetary missions to Mars, icy moons, or asteroids. Samples that indicate the presence of organics or other biomarkers of interest will be further analyzed using a miniature time-of-flight mass spectrometer to characterize trace levels of complex organics. This project is conducted in collaboration with Dr. Nancy Chanover of New Mexico State University, and uses various cave and surface microbiological and organic materials as test subjects for instrument development.

NASA Ames Research Center funded mathematical modeling using cellular automata techniques in an attempt to reproduce unusual microbial patterns that are seen in a number of caves. These "biovermiculations" appear to be a combination of biological and physical processes. In addition to the modeling, the team is designing long term monitoring experiments on living cave mats to study the effects of changing environmental parameters to mat development. Non-NCKRI team members include Dr. Keith Schubert and Dr. Ernesto Gomez (California State University, San Bernardino), Dr. Henry Sun (Desert Research Institute, Las Vegas), and Dr. Chris McKay (NASA Ames Research Center).

*NASA Planetary Biology Intern, Blaire Steven, from Canada, boiling samples for a geomicrobiology experiment in Fort Stanton Cave, New Mexico.
Photo courtesy of Kenneth Ingham.*



STUDENT ACTIVITIES

Cave and Karst Studies Mission Statement

Cave and Karst Studies at New Mexico Tech (NMT) is the academic program associated with NCKRI and is housed primarily within the Earth and Environmental Sciences Department at NMT. We are building a program of cave and karst research and teaching excellence, drawing attention to the unparalleled cave and karst resources of New Mexico and the American Southwest, while also helping to build the National Institute.

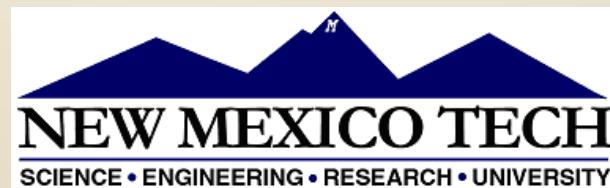
C&K NMT shares NCKRI's goals and has special objectives, which include:

- 1) Provide training for undergraduate and graduate students in cave and karst science. The academic scope includes geology, mineralogy, karst hydrology, microbiology, soils, environmental geochemistry, modeling of karst systems including micrometeorology, karst water resources, karst-related geohazards, and the potential for karst and cave features on other planetary bodies including the moon.
- 2) Develop world-class research facilities in support of this academic effort at NMT and with partners around the nation.
- 3) Promote the recruitment and development of students seeking careers dealing with karst and cave topics.
- 4) Promote integration and greater awareness of cave and karst sciences within the greater framework of the Earth sciences.
- 5) Promote awareness of the unique nature of karst aquifers and their role in providing groundwater resources.
- 6) Provide cave and karst educational experiences to interns from other agencies and organizations.
- 7) Build upon existing relationships with the U.S. National Park Service, Forest Service, Bureau of Land Management, and the cave resources that they manage.
- 8) Provide an academic resource in cave and karst expertise for other state and federal agencies, educational entities, and the public.
- 9) Participate in media coverage of cave and karst issues for print and broadcast venues locally, nationally, and internationally.
- 10) Bring the precious and often fragile cave and karst environments to the attention of K-12 educators and students, and the public.

Cave and Karst Studies Courses at NMT

A variety of regular courses and special topics are taught by Dr. Penelope Boston on a rotating 2-year frequency. For this reporting period, these have included:

Advanced Topics in Speleohydrology
Astrobiology
Astrogeology: Mars and Beyond
Cave & Karst Systems and Cave & Karst Laboratory
Extraterrestrial Dissolutional Landforms
Frontiers of Geobiology and Geomicrobiology
Karst Tufa Spring Mound Research
Model Impact Energetics of Earth and Mars
Moonmilk Research
Research Experience on Cave Pearl Origins



During this report's period, Dr. Boston supervised two Ph.D. students, two Master's students, one undergraduate senior thesis, and four independent study projects. Dr. Lewis Land served on three NMT graduate student committees, including that of Kevin Stafford who successfully defended his dissertation in March 2008 and soon after secured a tenure-track position as an assistant professor of geology at Stephen F. Austin University in Nacogdoches, Texas.

As part of NCKRI's broader educational outreach efforts, Executive Director Dr. George Veni joined the thesis committee of Kyle Cunningham, who is pursuing a Master's degree in environmental science at The University of Texas at San Antonio; her research focuses on monitoring groundwater quality in the karstic Edwards Aquifer, Texas.

STUDENT PROJECTS

During the 2007-2008 period covered by this Annual Report, the *Cave and Karst Studies Program* of NCKRI has been engaged in the largest number of ongoing and continuing projects in its history. Excellent students, extensive grant submission activities, the new Laboratory Research Associate, Dr. Rasima Bakhtiyarova, and ongoing support by Lisa Majkowski in developing budgets, grants, and funding opportunities has been invaluable in growing the active research program to this level of accomplishment. Many of the students have been involved with projects described on the preceding pages. Following are projects led by students, or where students have played major roles.

Snowy River, Fort Stanton Cave, New Mexico

NCKRI's *Cave and Karst Studies Program* has facilitated a NMT Senior Civil Engineering Design Class project to create an entry shaft and security bunker for the proposed drilled route to Snowy River. The shaft will make future research easier and possible in many cases, in addition to improving safety and preserving microclimatological and biological conditions in that unique section of the cave.

Visiting Spanish graduate student, Andrea Martin-Perez, sampling a speleothem in Fort Stanton Cave. Photo courtesy of Kenneth Ingham.



Micrometeorology of Caves

In conjunction with Dr. John Wilson and Dr. Anders Jorgensen of NMT, Dr. Scott Tyler of the University of Nevada in Reno, and Paul Burger of Carlsbad Caverns National Park, the *Cave and Karst Program* is developing physics-based models of micrometeorological processes in caves. Building on the work of former NCKRI Scholar, Setsuko Shindo, we are extending the modeling efforts and adding a major field component of optical fiber and eddy correlation analyses. A pilot field effort in March 2008 resulted in presentations to be given at the 2008 Geological Society of America Convention. Master's student Ravindra Dwivedi is focusing on both the modeling efforts and learning to conduct high precision field measurements of physical and chemical parameters in the challenging environments of caves.

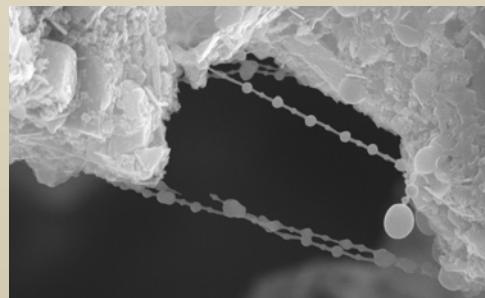
Origin of Moonmilk

This long-term project continues with the work of Master's student Megan Curry, under the supervision of Dr. Penelope Boston, and in collaboration with Dr. Diana Northup of the University of New Mexico and colleagues from several other institutions. The origin of pasty mineral deposits known collectively as "moonmilk" has long been debated. Evidence for biological, geochemical, and physical processes have all been found by different investigators. We are trying to discover how these formations depend on those different processes and if environmental conditions like moisture, organic nutrients, temperature, or underlying bedrock type affect the development or type of moonmilk produced. We are working in a variety of caves from limestone karst to lava tubes, with field sites in Alaska, California, Colorado, and New Mexico.

Sulfuric acid caves and sulfur springs of Tabasco, Mexico

Research continues on geomicrobiological, mineralogical, and geological aspects of this long-running project (1998-present). Ph.D. student Laura Rosales-Lagarde is working to determine the geological origins of the hydrogen sulfide and other gases and waters flowing into Cueva de Villa Luz and other sulfur caves and springs in the region of southern Tabasco, Mexico. Dr. Penelope Boston and colleagues from the University of New Mexico are studying the geomicrobiology of these systems. Rosales and Boston led a team of museum designers and educators from Chicago's Museum of Science and Industry through Cueva de Villa Luz (the primary sulfuric acid cave in the area) as part of their development of a new exploration science exhibit scheduled for that museum in 2011, entitled *Explore: Blue Planet, Red Planet*.

"Beads-on-a-string" structures from the Karst Information Portal's scanning electron microscopy database of cave microbial images; courtesy, Diana Northup.

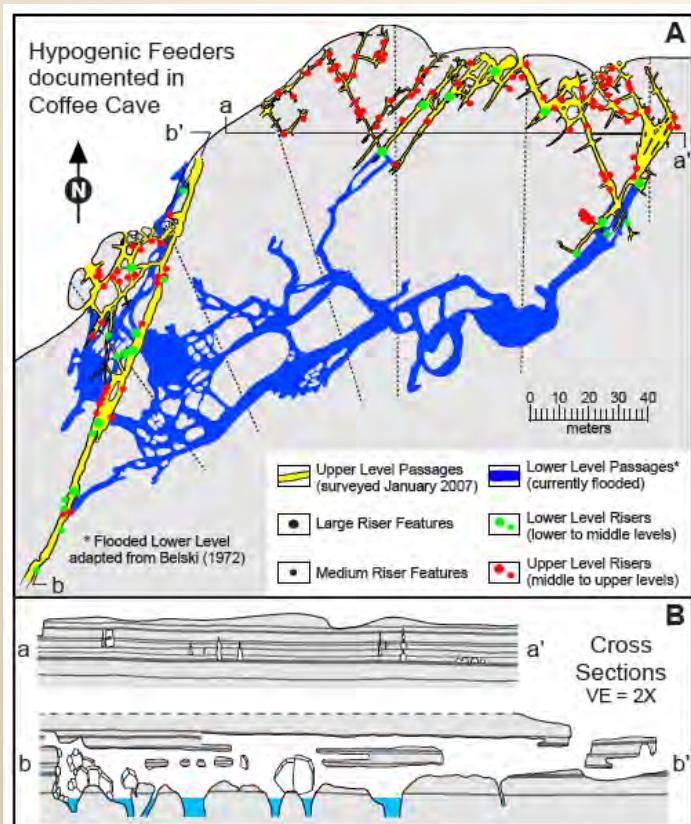


Salt Basin Aquifer Assessment

The Salt Basin is a tectonic depression of mostly Permian-age carbonate rocks that straddle the New Mexico/Texas border. The basin is bounded by the Guadalupe Mountains on the east, the Sacramento Mountains on the north, and Otero Mesa on the west. Prior to agricultural development, groundwater in the basin discharged to saline playas in the basin center, hence the feature's name. Since the 1940's, large amounts of water have been pumped for irrigated agriculture, mostly in the Texas portion. Additionally, strong interest has been expressed in the basin as a potential future water supply for El Paso, Ciudad Juarez, and Las Cruces. This current and proposed exploitation of the groundwater resources of the Salt Basin has highlighted the need for their long-term management. Starting in Summer 2007, we undertook a 3-year assessment of the potential water resources of the area. The project is sponsored by the Interstate Stream Commission and co-managed between Dr. Penelope Boston and New Mexico Tech Hydrology Professor, Dr. Fred Phillips. Three NCKRI student scholars, Andre Ritchie, Sophia Sigstedt, and Travis Swanson, are engaged in this hydrological assessment.

Gypsum Karstification & Evaporite Microbial Forms

Ph.D. student Kevin Stafford (graduated May 2008) worked intensively for the past three years on mapping, describing, and tabulating karst features on the Gypsum Plain area of west Texas and eastern New Mexico. He also conducted studies on the mineralogical textures of the evaporites, especially the surface remobilized "gypsiter" layer. Master's student Megan Curry did preliminary work on some aspects of the microbiological inhabitants of this biologically challenging environment. Some of the organisms have been shown to withstand Mars-like levels of high intensity and short wavelength ultraviolet radiation, extreme dessication, ultra-low pressures (20 mb), and a 100% CO₂ atmosphere as part of Mars simulation tests in partnership with TechShot, Inc. in Indiana.



Map and cross-sections of Coffee Cave, Eddy County, New Mexico. Figure provided by Dr. Kevin Stafford.

Coffee Cave

Coffee Cave is located in the lower Pecos River region of southeastern New Mexico, in the middle Permian Seven Rivers Formation. It is a rectilinear gypsum maze cave with at least four stratigraphically distinct levels. Morphological features throughout the cave provide unequivocal evidence of hypogenic speleogenesis (cave development from rising waters) in a confined aquifer system. Morphologic features in individual cave levels include a complete suite that defines original rising flow paths, ranging from inlets for hypogenic fluids (feeders) through transitional forms (rising wall channels) to ceiling half-tube flow features and fluid outlets (cupolas and exposed overlying beds). Passage morphology does not support origins based on epigenetic processes (descending waters) and lateral development, although the presence of fine-grained sediments in the cave suggests minimal overprinting by backflooding. It is likely that additional hypogenic karst phenomena are present in the vicinity of Coffee Cave because regional hydrologic conditions are optimum for confined speleogenesis, with artesian discharge still active in the region.

This reinterpretation of the origins of Coffee Cave has been documented in a chapter of Dr. Kevin Stafford's doctoral dissertation, and has been published in a 2008 issue of the Journal of Cave and Karst Studies. Dr. Stafford was lead investigator on the project. Dr. Lewis Land provided regional hydrologic context for the study and was second author. Dr. Alexander Klimchouk, Visiting NCKRI Scholar 2006-2007 and Executive Director of the Ukrainian Institute of Speleology and Karstology is third author.

STUDENT PUBLICATIONS

Rosales-Lagarde, L., Boston, P.J., Campbell, A., and Stafford, K.W., 2008. Possible structural connection between Chichón Volcano and the sulfur-rich springs of Villa Luz Cave (a.k.a. Cueva de las Sardinas), southern Mexico. *Bulletin of the Association for Mexican Cave Studies (Austin, TX)* 19(7):177-184.

Rosales Lagarde, L., Boston, P.J., Pullin, M., Stafford, K.W., 2007. Exploración de la extensión de la espeleogénesis por ácido sulfúrico en la región norte de Chiapas, sur de Tabasco, México. VIII Congreso Nacional Mexicano de Espeleología, Unión Mexicana de Agrupaciones Espeleológicas, Cuetzalan, Puebla, 2-5 Febrero, Memorias, p. 65-66.

Rosales-Lagarde, L., Spilde, M., Boston, P.J., Campbell, A., Pullin, M., and Stafford, K.W., 2007. Possible regional groundwater connections: Chemistry of H₂S-rich springs east of El Chichón Volcano: *in Espíndola, J.M., Arce, J.L., and Macías, J.L. eds., Proceedings of the Commemorative Conference “El Chichón Volcano: Twenty-five years later”*. Universidad Nacional Autónoma de México, Instituto de Geología, Publicación Especial 6. San Cristóbal de las Casas, Chiapas, México, p. 95.

Stafford, K.W., 2008. Cavernous porosity and associated sulfate diagenesis in the Castile Formation: Eddy County, New Mexico and Culberson County, Texas. *West Texas Geological Society Bulletin* 47(6):14-17, 20-26.

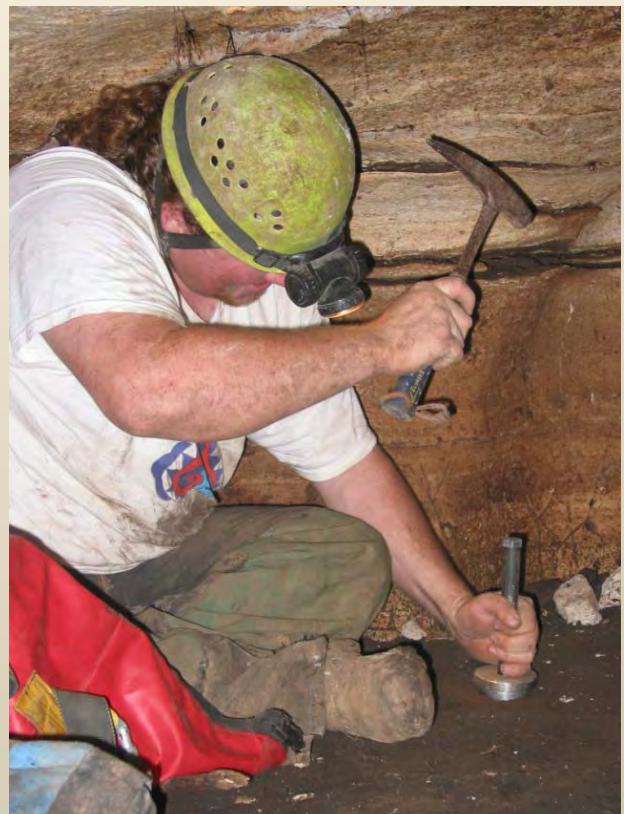
Stafford, K.W., Land, L., and Klimchouk, A., 2008. Hypogenic speleogenesis within Seven Rivers Evaporites: Coffee Cave, Eddy County, NM. *Journal of Cave and Karst Studies* 70(1):47-61.

Stafford, K.W., Nance, R., Rosales-Lagarde, L., and Boston, P.J., 2008. Epigene and hypogene karst manifestations of the Castile Formation: Eddy County, New Mexico and Culberson County, Texas, USA. *International Journal of Speleology* 37(2):83-98.

Stafford, K.W., Rosales-Lagarde, L., and Boston, P.J., 2008. Castile evaporite karst potential map of the Gypsum Plain, Eddy County, New Mexico and Culberson County, Texas: A GIS methodological comparison. *Journal of Cave and Karst Studies* 70(1):35-46.



NCKRI Scholar Laura Rosales Lagarde (right) with Ramon Espinosa examining roots in a lava tube in San Juan, Morelos, Mexico. Photo by Kenneth Ingham.



NCKRI Scholar Kevin Stafford collecting a sediment core for analysis from a Texas cave. Photo by George Veni.

OUTREACH

New NCKRI Logo

A new logo was adopted by NCKRI to reflect NCKRI's organizational change from an institute within the National Park Service to an independent non-profit corporation administered by New Mexico Tech. It elegantly represents caves as not simply isolated underground features but integral components of surface karst landscapes. Graphic artist Beth Fratesi was commissioned to create the new logo, which was accepted in October 2007. Beth is also completing her Ph.D. in karst geology at the University of South Florida, a key NCKRI partner in the Karst Information Portal and other activities.



Partnerships

Whether formal by contract or informal by casually working together, partnerships are key to NCKRI's success:

NCKRI Headquarters

Pessimists warn about too many cooks ruining meals. They overlook how team efforts can combine broad experience and insights to create feasts, as in the case of NCKRI Headquarters. The building is being designed through the combined efforts of NCKRI with its three founding partners: the federal government through the National Park Service, the State of New Mexico through New Mexico Tech, and the City of Carlsbad, which will hold the title to the building. Working with NCA Architects & Planners, from Albuquerque, New Mexico, progress has been slower than normal as team members refine the design into an outstanding model of sustainable construction that allows NCKRI to conduct research and business in ample laboratory, library, and office space, while educating the public about the importance of caves and karst through its museum, classrooms, and bookstore. With technical expertise from Bat Conservation International, NCKRI Headquarters will be the world's first building to include a bat roost as part of its design. The roost will be monitored with cameras, microphones, and probes. Frank Binney and Associates, Woodacre, California, is designing the museum plans, that will include several unique, state-of-the-art exhibits, some of which will tie into the bat roost, rainwater harvesting system, and ground-source heat pump, to combine sound environmentally friendly design with NCKRI's research and educational programs. Construction is expected to begin near the end of 2008. NCKRI Headquarters will be the first building of the Cascades redevelopment area along the beautiful Pecos River near downtown Carlsbad.



Right: eastward view toward the Pecos River.

Architectural perspectives of NCKRI Headquarters.

Left: view northwest from the Pecos River toward downtown Carlsbad.



New Mexico Bureau of Geology and Mineral Resources (NMBGMR)

NCKRI's hydrogeologist Dr. Lewis Land also works for NMBGMR and serves as a liaison to facilitate the exchange of information, expertise, and technical services. During this report period, he assisted NMBGMR with geologic field mapping of the Bitter Lakes and Lake McMillan North topographic quadrangles, as part of NMBGMR's StateMap project, in cooperation with the U.S. Geological Survey's National Cooperative Geologic Mapping Program (<http://ncgmp.usgs.gov>). Lake McMillan North is an area north of Carlsbad with abundant gypsum caves, sinkholes, and other gypsum karst features associated with both surficial dissolution and hypogenic processes, the result of upward leakage from the underlying San Andres aquifer through gypsum confining beds in the Seven Rivers Formation (see Coffee Cave report, p. 14). A preliminary version of the Lake McMillan North map and report are available for free download at: <http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/details.cfm?Volume=167>. See p. 4-5 for a summary of Dr. Land's work in the Roswell Artesian Basin, which includes Bitter Lakes. Bitter Lakes map and report are available at: <http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/details.cfm?Volume=151>

Dr. Land served on the NMBGMR search committee for a new hydrologist, which hired Talon Newton in December, 2007. NMBGMR functions as the focal point for the New Mexico Geological Society (NMGS). Dr. Land was NMGS President in 2007 and his five-year term of office on the NMGS Executive Committee will conclude at the end of 2008. His responsibilities on the Executive Committee this year included re-writing the guidelines for NMGS fall field conferences.

*Cavernous escarpment along the McMillan Reservoir.
Photo by George Veni.*



Conferences

NCKRI participated in and sponsored (*) numerous conferences, including booths with displays at the:

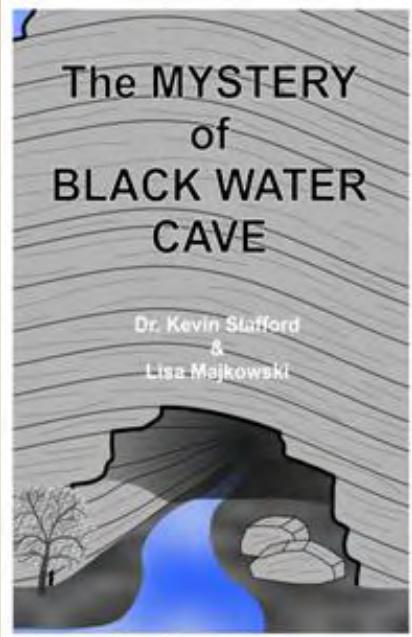
- National Speleological Society (NSS) Convention (Indiana, July 2007)
- Federation of Latin American and Caribbean Speleological Associations Congress (Puerto Rico, August 2007)
- International Conference on Karst Hydrogeology and Ecosystems (Kentucky, August 2007)
- U.S. Environmental Protection Agency Non-point Source Pollution Workshop (Texas, August, 2007)
- *National Cave and Karst Management Symposium (Missouri, October 2007)
- U.S. Forest Service Cave Conservation Café (Washington, D.C., October 2007)
- Geological Society of America Convention (Colorado, October 2007)
- Southwestern Region Winter Technical Meeting of the NSS (New Mexico, December 2007)
- American Geophysical Union Convention (California, December, 2007)
- American Planning Association Convention (Nevada, April 2008)
- *U.S. Geological Survey Karst Interest Group Workshop (Kentucky, May 2008)
- *Karst Waters Institute symposium -- *Karst from Recent to Reservoirs: International Conference on Paleokarst and Multi-permeability Flow Systems* (South Dakota, June 2008).

NCKRI's presence and activities at these events has been vital to strengthening relationships with the cave and karst community and introducing NCKRI to key people and organizations outside of those communities.



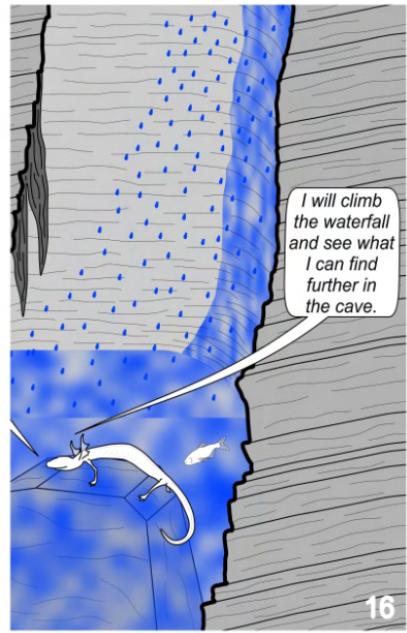
NCKRI is also the major sponsor of the 15th International Congress of Speleology (ICS). A function of the International Union of Speleology, the ICS is the world's premier speleological conference and is held only once every four years. The 15th ICS will be in Kerrville, Texas, in conjunction with the National Speleological Society's annual convention. Executive Director Dr. George Veni is Chairman of the 15th ICS, and serves on the governing board of the International Union of Speleology. NCKRI Board Chairman Hazel Medville, as well as other board members and many NCKRI partners are also on the 15th ICS Organizing Committee.

Education



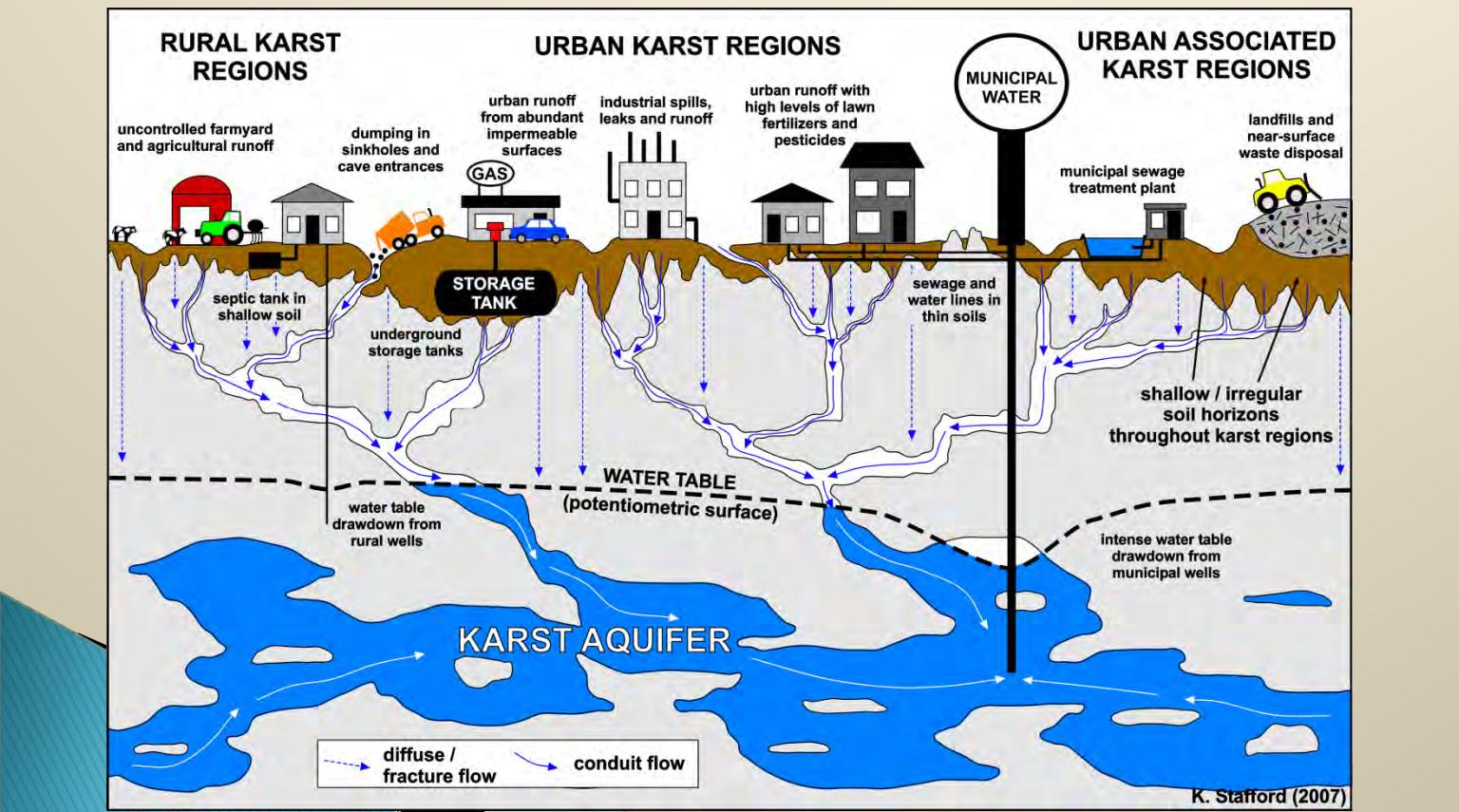
The Mystery of Black Water Cave

Dr. Kevin Stafford and Lisa Majkowski co-authored NCKRI's first children's book, *The Mystery of Black Water Cave* (in press). The story, centered on a puzzling pollution problem with the water quality in Black Water Cave, has a group of cave animals solving the mystery. The book is geared toward elementary-aged students and introduces them to trogloxenes Randy Raccoon and Jake Snake, troglophiles Bethie Bat and Penny Packrat, troglobites Mrs. Fish and Sally Salamander, and several other cave creatures. In addition to the book, Stafford and Majkowski produced a teacher's guide, which expands on cave geology, geomorphology, hydrology, and biology as well as human impacts on caves. The guide includes a map exercise related to the story, suggestions for student projects, and a list of cave and karst organizations.



Karst Contamination Diagram

Karst groundwater's vulnerability to pollution is difficult for people to visualize. While a student at New Mexico Tech as a NCKRI Scholar, Dr. Kevin Stafford produced the Karst Contamination Diagram to illustrate in conceptually simple ways how many human activities over karst aquifers can easily degrade the quality of public water supplies. The diagram is laminated and double-sided, with the reverse side in Spanish, translated by New Mexico Tech NCKRI Scholar Laura Rosales-Lagarde. The diagram is available as a teaching tool for all ages.



Community

Distinguished Lecture Series

NCKRI's Distinguished Lecture Series is a public education service provided to the City of Carlsbad and surrounding communities. It features people who have made major contributions to the understanding of caves and karst, with an emphasis on current hot topics. The series occurs in partnership with New Mexico State University – Carlsbad, with the generous assistance of Dr. Rick Wiedemann, which hosts the well-attended events. Two lectures were given in 2008:

Geological and Biological Discoveries at Sistema Zacatón: New Technologies in Underwater Cave Exploration

Marcus Gary, chief geologist of Environmental L.L.P., Buda, Texas, discussed the unique exploration and study of Sistema Zacatón, a water-filled cave system in northeastern Mexico that includes the world's deepest known cenote (sinkhole) El Zacatón. Gary is part of a research team working in the DEep Phreatic THermal eXplorer (DEPTHX) project, funded by NASA. The DEPTHX team has been developing a robotic submarine that could someday be used to explore the sub-ice oceans of Jupiter's moon Europa. Gary's team of explorers has been testing the robotic submarine in Sistema Zacatón, using it to map the cenotes, as well as collect biological, geological and hydrological samples. Gary's groundbreaking work has attracted international acclaim.

Tectonic Influences on the Origin of Caves in the Guadalupe Mountains, New Mexico and Texas

Harvey DuChene, past NCKRI Board Chairman, reconstructed the geological history which resulted in the creation of the Guadalupe Mountains and their world famous caves. Duchene transformed a highly complex and technological subject into a clear and concise presentation enjoyed by scientists and non-scientists alike.

NCKRI Lectures and Public Involvement

NCKRI regularly receives requests to give public lectures on its status and on caves and karst. During this report period, Dr. Lewis Land has spoken to the Roswell, New Mexico, Rotary Club and for Bottomless Lakes State Park. Executive Director Dr. George Veni has spoken to the Carlsbad Chamber of Commerce, Carlsbad Downtown Lions Club, Carlsbad Heights Lions Club, and to the Action Council for Employment. Dr. Veni is also an active member of the Carlsbad Chamber of Commerce and Carlsbad Rotary Club, regularly updating them on NCKRI activities. Dr. Patricia Seiser, NCKRI's Karst Stewardship Volunteer, is NCKRI's liaison with the National Speleological Society and cave rescue activities in southeastern New Mexico.



Slaughter Canyon, Guadalupe Mountains, New Mexico.

Photo by George Veni.

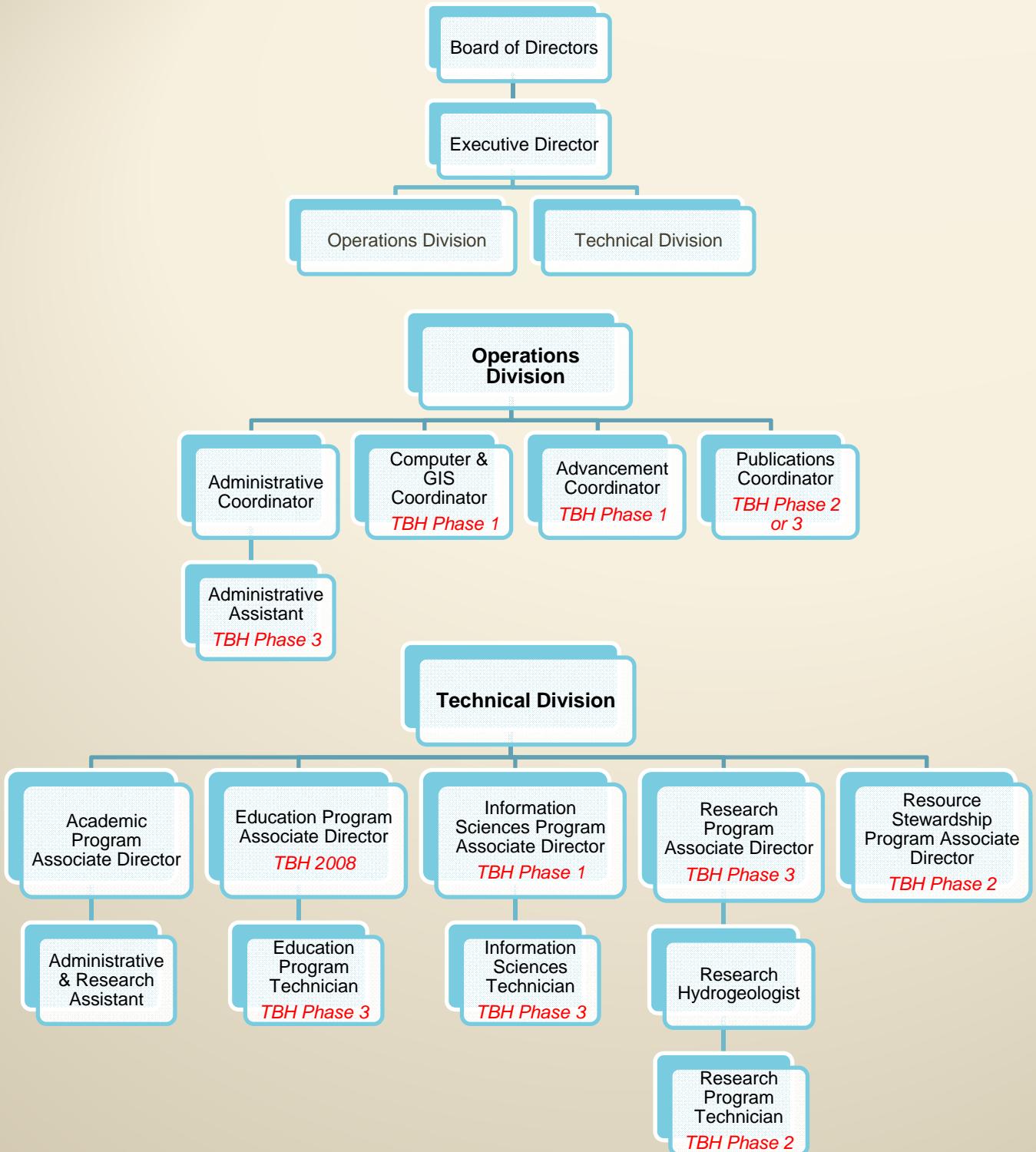


RiverBlitz 2008

Several NCKRI employees joined the annual RiverBlitz, an annual community cleanup day along the Pecos River. NCKRI teamed with the Pecos Valley Grotto of the National Speleological Society to work on the area near the McMillan Dam. Two pickup trucks were loaded with sorted, recyclable trash. NCKRI was a financial sponsor for the event, and Dr. Lewis Land lectured on the karst-related issues leading to the failure of the McMillan Reservoir.

NCKRI and Pecos Valley Grotto RiverBlitz 2008 team.
Photo courtesy of Bill Weston.

ORGANIZATIONAL STRUCTURE



TBH:

Phase 1:

Opening of NCKRI Headquarters (ca. 01/2010)

Phase 2:

FY 2010 – 2011

Phase 3:

FY 2011 – 2013

(all hiring periods and positions dependent on available funding and needs)

BOARD ACTIVITIES

Hazel Medville, Chairman

Committees of the Board of Directors continued to work on the Karst Information Portal (KIP), Research Directions for NCKRI, museum plans, and the definition of membership classes for NCKRI. The Board approved the following actions and activities during fiscal year 2007-2008:

- Strategic planning goals
- Policies for NCKRI employee and non-employee travel
- Contract with Frank Binney and Associates to design a conceptual exhibit plan for a museum on the ground floor of the new NCKRI Headquarters Building in Carlsbad, New Mexico
- Contract with Dr. Alexander Klimchouk to assist with the upgrading of the online Speleogenesis journal and its contributions to KIP
- Funding to test an experimental mathematical approach to teaching, in partnership with the National Numeracy Network, by numerically modeling speleogenesis with students from New Mexico Tech, University of New Mexico, and the University of South Florida
- Facilitation of the design a gate at the proposed new entrance for Fort Stanton Cave, New Mexico
- Major sponsorship of the 15th International Congress of Speleology, to be held in Kerrville, Texas in July 2009
- Sponsorship of a meeting of the U.S. Geological Survey Karst Interest Group, held in Bowling Green, Kentucky in May 2008
- Sponsorship of the Karst Waters Institute symposium, *Karst from Recent to Reservoirs: International Conference on Paleokarst and Multi-permeability Flow Systems*, held in Rapid City, South Dakota, June 2008

The May 2008 NCKRI Board meeting was held in NCKRI's offices in Carlsbad, New Mexico, which are leased from the Permian Basin Regional Training Center until NCKRI Headquarters is constructed. Photo by George Veni.



BOARD OF DIRECTORS

Hazel Medville – Chairman

- Member since 2005; Chairman since 2006; Bachelor's degree in Statistics and Computer Science
- Hazel is a retired Computer Engineer/Manager who now spends much of her time surveying caves in Hawaii and Colorado. She has been the President Pro-Tem and Government Liaison for the National Speleological Society, is currently the director of the West Virginia and Hawaii Speleological Surveys, and is active in organizing the 15th International Congress of Speleology.

Dale Pate – Vice Chairman

- Member from 2000-2002, 2006 to present, and has been Vice Chairman since 2006; Bachelor's in Geography
- Dale has been the National Park Service Acting Cave and Karst Program Coordinator since May 2007, and a Supervisory Physical Scientist (Cave Specialist) at Carlsbad Caverns National Park since July 1991.

Richard Cervantes – Secretary/Treasurer

- Member since 2005; Permanent position representing New Mexico Tech; Master's Degree in Accounting and Information Systems, and is a CPA
- Richard is the Associate Vice President of Research and Economic Development with New Mexico Tech; he is responsible for administrative affairs including budget preparation, fiscal and project management, proposal development and contract negotiation.

Carol McCoy

- Member since July 2007; Permanent position representing the National Park Service (NPS); Law Degree, Master's Degree in Public Policy, Bachelor's Degree in Environmental Studies
- Carol is the Chief of the Planning, Evaluation and Permits Branch of the NPS Geologic Resources Division; she manages a multi-disciplinary staff that provides policy and technical expertise to all levels of the NPS organization on a variety of geologic and minerals management issues, including cave and karst resource stewardship. She has also worked for a law firm, the U.S. Environmental Protection Agency, and George Washington University.

Harry Burgess

- Member since 2005, Permanent position appointed by the Mayor of Carlsbad, New Mexico; Bachelor's in Industrial Relations; Master's in Fire and Emergency Management Administration; Master's of Business Administration
- Harry represents the City of Carlsbad in its participation with NCKRI. He is Carlsbad's City Administrator, but also has a caving background, having worked previously with the National Park Service and being on the Board of the National Cave Rescue Commission. He also taught caving for the National Outdoor Leadership School.

Dr. Ronald T. Green

- Member since November 2007; Bachelor's in Industrial Engineering; Bachelor's in Geology; Master's in Geophysics; Ph.D. in Hydrology
- Ronald is a Hydrogeologist with the Southwest Research Institute, San Antonio, Texas

Jim Goodbar

- Charter board member; Bachelor's in Park and Recreation Management, also Graduate Studies in Cave & Karst Resources, Geology, and Geomorphology
- Jim works for the U.S. Bureau of Land Management (BLM) as the Senior Cave and Karst Resources Specialist with the Washington Office. Jim also serves as the BLM New Mexico State Cave Coordinator and as the Senior Cave and Karst Specialist for the BLM Pecos District and the Carlsbad Field Office. His duty station is located in Carlsbad, New Mexico, and his primary duties are to establish policy and provide guidance on cave and karst resources management to BLM field offices across the United States, serve as the international point of contact for all cave/karst related issues and requests for assistance, develop and conduct training courses for cave/karst resources, and develop best management practices for land use actions in karst lands.

Dr. John (Jack) Hess – Member at Large

- Member since 2005; Member at Large of Executive Committee; Ph.D. in Geology
- Jack is the Executive Director of the Geological Society of America (GSA). Prior to joining GSA in 2001, he was Executive Director of the Division of Hydrologic Sciences and Vice President for Academic Affairs at the Desert Research Institute in Nevada. John currently serves on the board of the Karst Waters Institute, and Longs Peak Council of the Boy Scouts of America, as well as NCKRI. John is a Fellow of the Geological Society of America, the National Speleological Society, and the Cave Research Foundation.

Dr. Kathleen Lavoie

- Member since 2006; Ph.D. in Biological Sciences
- Kathleen is a Biologist and Professor and Dean of the Faculty of Arts and Sciences at the State University of New York College at Plattsburgh. Since 1974, she has studied the biology of animals that live in caves. Her research deals with microbiology, geomicrobiology, cave crickets, sulfur cave systems, and invertebrate ecology with a smattering of work on bats. Kathleen was honored to receive the Science Award from the National Speleological Society in 2007 in recognition of her long term contributions to cave science.

Dr. Donald McFarlane

- Member since 2005; Bachelor's and Master's degrees in Zoology, and a Ph.D. in Ecology
- Donald is a Professor of Biology, The Claremont Colleges, California. His professional interests are in Late Pleistocene mammalian extinctions and paleoecological records from caves. He has been caving since 1973, and done research in the West Indies, Mexico, Ecuador, Europe, Kenya, New Zealand, Malaysia, and the U.S.

Dr. Diana Northup

- Member since May 2006; Ph.D. in Biology
- Diana is Professor Emerita in the University Libraries at the University of New Mexico and a Visiting Associate Professor of Biology, Albuquerque, New Mexico. Since 1984, he has studied organisms that live in caves. Diana and her colleagues on the SLIME (Subsurface Life In Mineral Environments) Team investigate microbial interactions with rock surfaces in caves and in desert varnish.

Randall Orndorff

- Member from December 2000-2004 and 2006 to present; Bachelor's and Master's degrees in geology
- Randall is currently the Associate Program Coordinator for the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program. He has been with the USGS since 1981 as a geologic mapper and expert on the geology of the Cambrian-Ordovician carbonate rocks of the Central Appalachians and Ozarks. His karst work includes geologic controls and frameworks on karst development of the Appalachians and Ozarks.

Geary Schindel

- Member since 2004; Bachelor's degree in Geology and a Master's degree in Geography.
- Geary is the Chief Technical Officer of the Edwards Aquifer Authority in San Antonio, Texas and directs the science research programs. The Edwards Aquifer is a major karst aquifer that provides water to more than 1.7 million people in south-central Texas.

Dr. Jerry Trout

- Charter board member; Ph.D. in Education
- Jerry is with the U.S. Forest Service (USFS) at the Coronado National Forest in Tucson, Arizona; he coordinates all phases of cave management, conservation, and research for USFS in the United States. He became the first cave specialist for USFS in 1972. Jerry's first caving trip was in Carlsbad Cavern in 1947.

Dr. H. Len Vacher

- Member since 2005; Ph.D. in Geology
- Len is a Professor of Geology at the University of South Florida where he has taught hydrogeology for many years and studied young carbonate islands experiencing diagenesis (settings for eogenetic karst). His teaching and sponsored research now focuses on math concepts for geologists and cross-curriculum quantitative literacy. One of the founding directors of the National Numeracy Network, a nonprofit membership organization promoting quantitative literacy, he is now a managing editor of its new open-access journal, *Numeracy*.

NCKRI STAFF

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. He has also conducted extensive karst research throughout the United States and in several other countries, 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, and has served as a member of the governing board of the International Union of Speleology since 2002. He is as a doctoral committee advisor for geological and biological dissertations at The University of Texas and teaches karst geoscience courses as an adjunct professor for Western Kentucky University. He has published and presented over 160 papers, including four books, on hydrogeology, biology, and environmental management in karst terrains.

Dr. Penelope Boston – Academic Program Associate Director

Dr. Boston administers NCKRI's Cave and Karst Studies program at New Mexico Tech. Boston teaches classes in cave and karst science, geomicrobiology, astrobiology, and global systems, and supervises a suite of graduate students working on those topics. Dr. Boston received a National Research Council Postdoctoral Fellowship at NASA-Langley Research Center in Virginia, has held positions at NCAR, the University of Colorado, University of New Mexico, and founded and operated her own non-profit research institution (Complex Systems Res., Inc.) for 14 years before joining NCKRI in 2002. She is a Fellow of the NASA Institute for Advanced Concepts, Past President of the Association of Mars Explorers, Senior Editor of the journal *Astrobiology*, member of the NASA Advisory Council Committee on Planetary Protection, member of the National Academy of Sciences COMPLEX committee, and past advisory board member of the *Journal of Cave & Karst Studies*.

Dr. Lewis Land – Karst Hydrologist

Dr. Land works for the New Mexico Bureau of Geology and Mineral Resources as their karst hydrologist for southeastern New Mexico, and also serves as the Bureau's liaison with the National Cave and Karst Research Institute. Prior to his career as a hydrogeologist, he spent eight years in the petroleum industry exploring for new oil reserves in the Mid-Continent and Rocky Mountain regions of the U.S., and offshore West Africa. His Ph.D. research included submersible investigations of submarine sinkholes in the Straits of Florida. Dr. Land spent two years with the North Carolina Division of Water Resources conducting geophysical surveys of aquifers beneath the coastal plain of eastern North Carolina before coming to NCKRI and New Mexico Bureau in 2003.

Debbie Herr - Administrative Coordinator

Debbie graduated from New Mexico State University - Carlsbad in 1990 with an Associate's Degree in Secretarial Administration. She started working at NCKRI in January 2008. Before that time Debbie spent 11 ½ years in the Truth or Consequences Municipal School District as a secretary and musical accompanist.

Lisa Majkowski – Cave & Karst Studies Program Liaison

Lisa works for the New Mexico Tech Earth and Environmental Science Department as the Earth Systems Specialist, as well as being the Cave and Karst Studies Program liaison with NCKRI. Lisa received a B.S. degree in geology from New Mexico Tech and has held a professional staff position with New Mexico Tech since 2004. Focus areas include grant budget management, technical meeting development, proposal management, national conference exhibiting, scientific and technical editing, and GIS. In addition to her role with NCKRI, Lisa is also the program manager for several projects including CRONUS-Earth, NM-EPSCoR (Hydrology), and the Interdisciplinary Science for the Environment REU.

Dr. Patricia Seiser – Karst Stewardship Volunteer

Dr. Seiser specializes in cave and karst stewardship. Her research in cave and karst stewardship focuses on the concept of Cave Wilderness. She is a Fellow of the National Speleological Society (NSS), where she has been a member for over 20 years, and serves as the NSS/NCKRI liaison. Dr. Seiser serves on the board of the Cave Research Foundation, has been an instructor for 10 years with the National Cave Rescue Commission, and is an adjunct professor with New Mexico Tech. In addition to volunteering for NCKRI, she works with the National Park Service, the Bureau of Land Management, and the Forest Service. In 1998 she was named as one of 20 women recognized for their exploration and research work at Carlsbad Caverns National Park.

STAFF PUBLICATIONS

Published Reports and Journal Articles

- Boston, P.J. 2008. Global Ecology: Gaia. In, *Encyclopedia of Ecology*. Elsevier Press. Pp. 1727-1730.
- Boston, P.J. 2008. Manganese-iron microbially produced minerals in caves and desert varnish. End of project report. NSF Low temperature geochemistry and geobiology.
- Dubowsky, S., Plante, J.S., Boston, P.J. et al. 2008. Hopping mobility concept for subsurface search and rescue robots (IR-07-578). Invited paper. *Industrial Robot* 35(3):238-245.
- Land, L. & Burger, P., 2008, *Rapid recharge events in a semi-arid environment: Two examples from karstic aquifers in southeastern New Mexico*, Sasowsky, I., Feazel, C., Mylroie, J., Palmer, A., & Palmer, M., eds., Karst: From Recent to Reservoirs: Karst Waters Institute Special Publication 14, p. 116-120.
- Land, L. & Newton, B. T., 2008, *Seasonal and long-term variations in hydraulic head in a karstic aquifer: Roswell Artesian Basin, New Mexico*: Journal of the American Water Resources Association, v. 44, p. 175-191.
- Land, L. & Newton, B. T., 2007, *Seasonal and long-term variations in hydraulic head in a karstic aquifer: Roswell Artesian Basin, New Mexico*: New Mexico Bureau of Geology and Mineral Resources Open-File Report no. 503, 27 p.
- McCraw, D. J. & Land, L., 2008, Preliminary Geologic Map of the Lake McMillan North 7.5-Minute Quadrangle Map, Eddy Co., New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map-167, 1:24,000.
- McCraw, D. J., Rawling, G. & Land, L., 2007, Preliminary Geologic Map of the Bitter Lake Quadrangle, Chaves Co., New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map-151, 1:24,000.
- Rawling, G., Timmons, S., Newton, T., Walsh, P., Land, L., Kludt, T., Timmons, M., Johnson, P., & Felix, B., 2008, Sacramento Mountains Hydrogeology Study, Progress Report, July, 2008: New Mexico Bureau of Geology and Mineral Resources, Aquifer Mapping Program, 50 p.
- Veni, G., 2008, Review of: *Redefined Edwards Aquifer Recharge Zone Limits*: Bulletin of the South Texas Geological Society 48(7): 67-70.

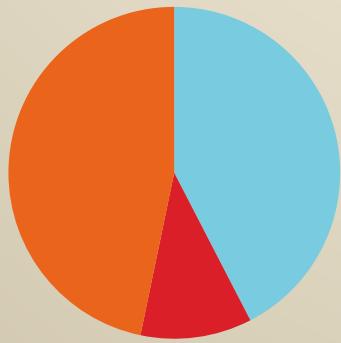
Conference Abstracts

- Boston, P. J., & Veni, G., 2008, *National Cave and Karst Research Institute: a partner for the USGS*. Karst Interest Group Workshop, Bowling Green, Kentucky, U.S. Geological Survey.
- Fleury, S., Veni, G., Chavez, T.A., Boston, P.J., Northup, D.E., & Vacher, L., 2007, Superior karst stewardship through superior data management: the Karst Information Portal. National Cave and Karst Management Symposium, St. Louis, Missouri.
- Huff, G. F. & Land, L., 2007, *Geochemical evolution and apparent flow rates of groundwater in the San Andres limestone, Bitter Lake National Wildlife Refuge, Chaves County, New Mexico*: New Mexico Water Resources Research Institute, 2007 New Mexico Water Research Symposium, abstracts with programs, p. C-2.
- Land, L., 2007, *Evaluation of groundwater residence time in a karstic artesian aquifer using natural and anthropogenic tracers: Roswell Artesian Basin, New Mexico*: GSA Abstracts with Programs, v.39, no. 6, p. 330.
- Land, L., 2007, *Preliminary results of surface and subsurface water chemistry sampling in the vicinity of Fort Stanton Cave, Lincoln Co., NM*: National Speleological Society-Southwest Region, Winter Technical Meeting, Las Cruces, NM, Abstracts with Programs.
- Timmons, S., Rawling, G., Land, L., & Johnson, P., 2007, *Preliminary water chemistry results from a hydrogeologic study in the southern Sacramento mountains, New Mexico*: GSA Abstracts with Programs, v.39, no. 6, p. 40.
- Veni, G., 2007, Keynote address -- *Non-point source pollution of karst groundwater: a poorly-recognized national crisis*: Proceedings, 15th National Nonpoint Source Monitoring Workshop, Austin, Texas, pp. 16.
- Veni, G., 2008, *Karst groundwater: a national treasure, a national crisis* (invited lecture). American Planning Association Convention, Las Vegas, Nevada.
- Veni, G., Northup, D.E., Boston, P.J., Chavez, T.A., Brinkmann, R., Vacher, H.L., Klimchouk, A., Collins, L. & van Reenen, J., 2007, *Enhancing communication and knowledge discovery among karst scientists: the role of the Karst Information Portal (KIP)*: Geological Society of America Convention, Denver, Colorado.

2007-2008 BUDGET

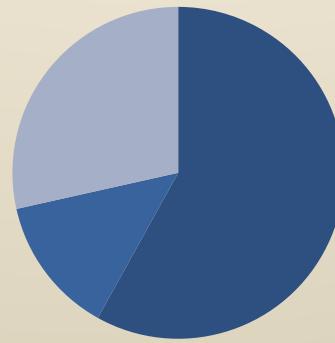
	<i>National Park Service</i>		<i>State of New Mexico</i>		<i>COMBINED</i>	<i>COMBINED</i>
	FY07 Budget	FY07 Actuals	FY07 Budget	FY07 Actuals	FY 07 COMBINED BUDGET	FY 07 COMBINED ACTUALS
PROJECT SALARIES						
Staff	135,000	74,058	137,563	127,398	272,563	201,456
Students			50,000	90,066	50,000	90,066
Project Salaries Sub-total	135,000	74,058	187,563	217,464	322,563	291,522
FRINGE BENEFITS						
Staff	43,200	25,912	38,186	39,902	81,386	65,814
Students			1,000	1,801	1,000	1,801
Fringe Benefits Sub-total	43,200	25,912	39,186	41,703	82,386	67,615
TOTAL PERSONNEL EXPENSES	178,200	99,970	226,749	259,167	404,949	359,137
OPERATING EXPENSES						
Maintenance Fund/Rent						
Utilities and janitorial						
Supplies & Expense	10,000	24,800	64,251	7,807	74,251	32,607
Telephone Equipment Charges		1,500	4,000	981	4,000	2,481
Travel	15,000	25,460	30,000	25,903	45,000	51,363
Equipment		1,580	152,300	2,403	152,300	3,983
Programs	20,000	6,134		-1,541	20,000	4,593
NMT Administrative Support			25,000	20,000	25,000	20,000
NMT "Indirect" from NPS Budget (8%)	19,400	12,685			19,400	12,685
NPS "Indirect" to GRD at 6% on NPS appropriation	15,400	15,400			15,400	15,400
TOTAL OPERATING EXPENSE	79,800	87,559	275,551	55,553	355,351	143,112
TOTAL PROPOSED BUDGET	258,000	187,529	502,300	314,720	760,300	502,249

FY 07 COMBINED BUDGET



- PERSONNEL SALARIES
- PERSONNEL BENEFITS
- OPERATING EXPENSES

FY 07 COMBINED ACTUALS



- PERSONNEL SALARIES
- PERSONNEL BENEFITS
- OPERATING EXPENSES

STRATEGIC PLANS

Below are highlights of NCKRI's Strategic Plan, relative to its fiscal year which begins annually on 1 July. Goals are generally described and include annual evaluations of progress toward them and overarching concepts.

Vision Statement

NCKRI will be the world's premier cave and karst research organization, facilitating and conducting programs in research, education, data management, and stewardship in all fields of speleology through its own efforts and by establishing an international consortium of partners whose individual efforts will be supported to promote cooperation, synergy, flexibility, and creativity.

FY 2008-2009

- Hire an Education Associate Director
- Begin construction of NCKRI Headquarters
- Conduct building-related fundraising for additional or superior exhibits, equipment, and construction, and to endow key staff positions and projects
- Continue working with Congress to revise NCKRI's enabling legislation to remove federal funding constraints
- Develop lists of potential projects and sponsors/partners; begin working toward the most likely or crucial
- Develop a membership program
- Conduct research and begin preparation to establish a NCKRI Foundation
- Develop job descriptions and select personnel to fill those jobs when NCKRI Headquarters is ready to be staffed

FY 2009-2010

- Assist with the 15th International Congress of Speleology and begin intensively initiating international partnerships, projects, and associated fund-raising
- Move into NCKRI Headquarters; newly selected staff begins work
- Establish a NCKRI Foundation
- Continue high-level national and international campaign for fund and partnership building associated with the grand opening of NCKRI Headquarters
- Begin local to national karst education programs for K-12, universities, agencies, and organizations
- Begin efforts to establish an international cave sample archive facility
- Begin intensively initiating national partnerships, projects, and associated fund-raising, with the goal of establishing a consortium that can more effectively work to solve basic and applied problems, and be more competitive in receiving funding
- Begin development of an international karst research coalition, to include a network of laboratories and field research sites

FY 2010-2011

- Reestablish the NCKRI Visiting Scholar Program, preferably as an endowed position
- Begin a student research grant and internship program tied to NCKRI projects and partners

FY 2011-2013

- Karst education program is established with major universities and agencies
- Complete development of a national karst research coalition, to include a network of laboratories and field research sites, and begin expanding it into an international karst research coalition

FY 2013-2018

- Karst education program is established with many universities and agencies in karst areas
- Complete development of an international karst research coalition
- Construct a building separate from NCKRI headquarters for research and archival storage of library and other materials, and as a field station for visiting scholars and students



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