

2006 – 2007 Annual Report



N C K R I

January 1, 2006 through June 30, 2007

EXECUTIVE SUMMARY

The years 2006 and 2007 were pivotal years in the history of the National Cave and Karst Research Institute (NCKRI). The previous years had been productive but also instructive in how NCKRI could better achieve its goals. The primary partners, the National Park Service (NPS), State of New Mexico through the New Mexico Institute of Mining and Technology (New Mexico Tech – NMT), and the City of Carlsbad, followed groundwork laid during 2005 and recast NCKRI as NCKRI, Inc., an independent non-profit institute. NCKRI, Inc. retains all of its previous support and federal mandates, and as a non-profit is better able to fulfill those mandates. NMT was designated as the administrator of NCKRI funds and contracts, as well as the employer of NCKRI staff.

The first NCKRI Board of Directors met in May 2006, dissolving the Interim Board of Directors established the previous year. Also at that time, Dr. Hose began to transition from her job with NCKRI into a new position, continuing her employment with the NPS in Washington, D.C. Ronal Kerbo was assigned as Acting Director until a new Executive Director could be found. Following a nationwide search, Dr. George Veni was selected in October 2006 and began work in February 2007. In March 2007, Ron Kerbo retired following 31 years of distinguished service for the NPS. The efforts and leadership of Dr. Louise Hose and Ron Kerbo were crucial in the development of NCKRI and are greatly appreciated. Additionally, the flexibility and tremendous support of the NPS in allowing NCKRI to find the best way to advance itself deserves special note and recognition.

Many NCKRI activities were placed on hold, beginning in mid-2006, until a new Executive Director could be hired. Activities that did occur include:

- several student projects from NCKRI's Cave and Karst Program at NMT, which ranged from geology, to microbiology, to extraterrestrial;
- hydrogeologic evaluation of the karstic Roswell, New Mexico, Artesian Aquifer;
- production of NCKRI's first publication, Special Paper No. 1: *Hypogene Speleogenesis: Hydrogeological and Morphogenetic Perspective*, a result of NCKRI's Visiting Scholar Program and visiting scholar Dr. Alexander Klimchouk, Executive Director of the Ukrainian Institute of Speleology and Karstology;
- preparation of the Karst Information Portal for public release;
- redesign of the NCKRI website to reflect and inform about the current transitional period;
- sponsor the 57th New Mexico Geological Society Fall Field Conference with the production of a major guidebook, *Caves and Karst of Southeastern New Mexico*;
- support of the U.S. Geological Survey's work to produce a new national karst map;
- support of Western Kentucky University's karst graduate student program;
- support of microbiological studies at Western Kentucky and Northern Kentucky universities;
- redesign of NCKRI Headquarters for construction in fiscal year 2008-2009;
- development of a 10-year strategic plan for NCKRI goals and activities.

This 18-month reporting period marks the transition from the previous annual reports based on the calendar year to the NMT fiscal year, which begins on 1 July.

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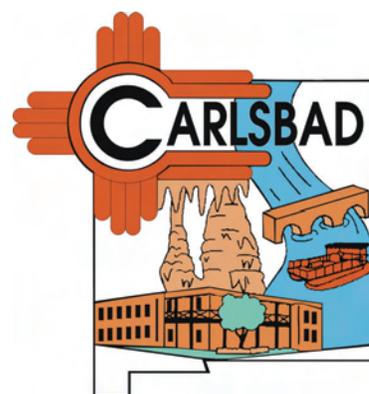
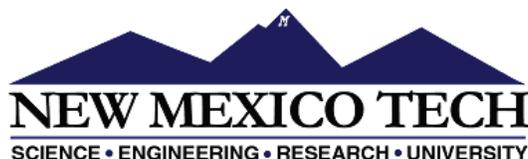
***Cover photo:** Gypsum karren seen on NCKRI-sponsored 2006 New Mexico Geological Society Fall Field Conference, Eddy County, New Mexico. Photo by George Veni.*

***Back cover photo:** Coraloid-covered dripstone speleothems in Caverns of Sonora, Sutton County Texas, described as a hypogenic cave in NCKRI Special Paper No. 1. Photo by George Veni.*

A TIME OF CHANGES AND NEW BEGINNINGS

Overview

During 2006 and 2007, the National Park Service (NPS), State of New Mexico, and the City of Carlsbad oversaw a key transitional time in NCKRI's history. This period saw the completion of several important structural changes, such as the formal establishment of a broad-based NCKRI Board of Directors and the transfer of funding and day-to-day NCKRI administration to the New Mexico Institute of Mining and Technology (New Mexico Tech or NMT) through a cooperative agreement between NPS and NMT, completing the establishment of a multi-party public and private research and education organization. Several changes in key personnel that were involved in the early development of NCKRI also occurred over this period with new people taking over in key roles including the Carlsbad City Administrator, the NCKRI Executive Director, the NCKRI building architectural firm, and the NPS as lead official. Highlights of the changes and developments during this period are summarized below.

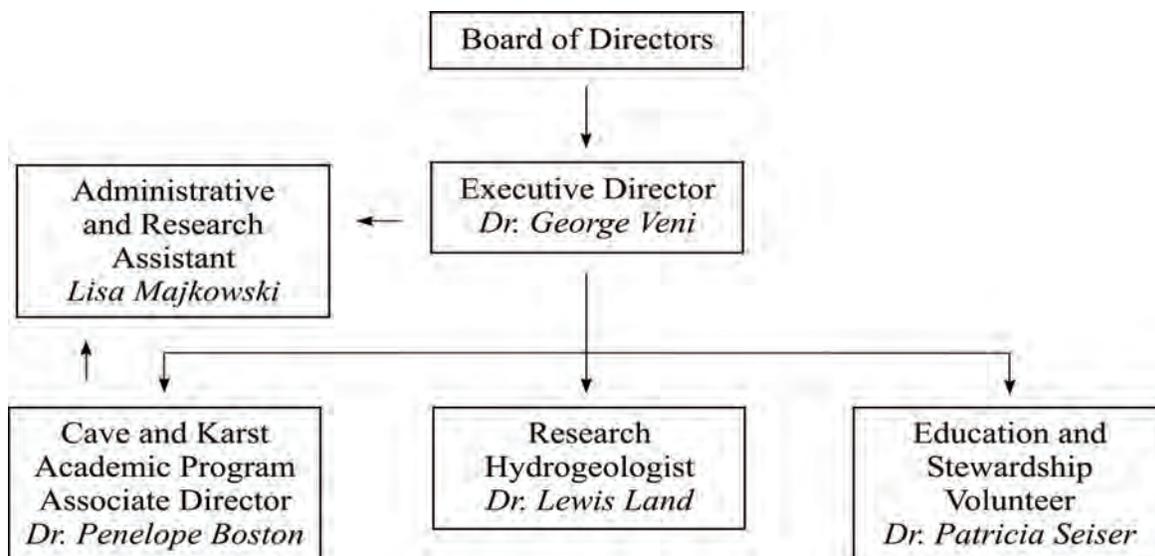


Executive Director Transition

New Mexico Tech (NMT) initiated the recruitment for a NCKRI Executive Director in late 2005, with the extensive search effort continuing through most of 2006. As specified in the NCKRI Bylaws, a search committee of Board members was established to advise NMT in this hiring process. After reviewing the initial group of applicants in March, the committee advised that the initial applicant pool was too small and that the search should be extended, which was done by NMT. Concurrently with the ongoing search process, the NPS undertook actions to shift existing NPS-NCKRI staff to other NPS program areas. Particular changes included assigning Dr. Louise Hose to other functions within the Geologic Resources Division and Natural Resources Directorate and assigning Ron Kerbo as Acting NPS-NCKRI Director pending NMT's selection of an Executive Director. The NPS Board representative, Dave Shaver, participated on the search committee including attending September 2006 interviews of potential candidates in Carlsbad. NMT completed the search process and announced the selection of Dr. George Veni for the Executive Director position at the October 2006 NCKRI Board meeting. Dr. Veni officially started as NCKRI Director in February 2007, after which time the NPS has not had operational involvement in day-to-day NCKRI activities.

Organizational Overview - Current Status

NCKRI operations are divided between Carlsbad and Socorro, New Mexico. The organizational chart below outlines staffing and relationships during the time of this report. General direction and oversight is provided by the Board of Directors, which includes representatives of the three partners that created NCKRI. Day-to-day business and specific actions and directions are conducted by, and provided by, Executive Director Dr. George Veni in Carlsbad. Also in that office are Dr. Lewis Land and Dr. Patricia Seiser. Dr. Land leads NCKRI's hydrogeological research program. Dr. Seiser is a volunteer, assisting in many ways with a focus on education and stewardship programs. At NMT in Socorro, Associate Director Dr. Penny Boston leads the academic Cave and Karst Program, educating and advising up to Ph.D. level students. Lisa Majkowski provides her, and the NCKRI-supported students, administrative and technical assistance. Richard Cervantes, NMT Associate Vice President for Research and Economic Development and NCKRI Secretary-Treasurer, leads and coordinates NCKRI financial and administrative activities conducted through NMT.



The New Role of the National Park Service Within NCKRI

Through the establishment of the broad-based, public-private partnership to direct NCKRI activities, as outlined by the organizational changes above, the NPS has largely completed its Congressional mandate from the 1998 NCKRI Act. While the NPS will remain a primary NCKRI partner and member of the Board of Directors, along with the City of Carlsbad and NMT, the NPS role in NCKRI's day-to-day operations is significantly reduced from that of the earlier period. As a permanent member of the Board, the NPS lead official will continue to participate in setting the general direction and programmatic emphasis for NCKRI operations. The NPS official will also retain indirect control through the annual NCKRI budget process by exercising approval authority relative to the expenditure of Federal funding provided through NPS appropriations. A continuing primary concern for the NPS will be to ensure timely and efficient transfer of state-of-the-art cave and karst science to the NPS resources specialists, park managers, and other federal agencies. To facilitate this process and assist in the overall direction of NCKRI programs, representatives from NPS parks and other federal agencies may also participate as elected members of the Board or otherwise participate in NCKRI educational, resource management, or research efforts.

NCKRI Administration Transfer

In keeping with the direction of the 1998 NCKRI Act, in 2005 the NPS initiated steps to shift day-to-day operation of the Institute to the academic partner, NMT, while retaining a NPS administrative oversight role. Pursuant to earlier primary partner agreements, this transfer consisted of three main components:

- Forming NCKRI, Inc. as a non-profit corporation within the research park of NMT, which was accomplished in late 2005;
- Establishing corporate Bylaws and a multi-party Board of Directors to help guide overall NCKRI program development; and
- Hiring a NCKRI Executive Director through New Mexico Tech as an NMT employee.

NCKRI, Inc. was established in December 2005 as an incorporated entity in the State of New Mexico. It established a Board of Directors consisting of one permanent member each from the NPS, NMT, and City of Carlsbad, with nine additional members possessing a broad range of expertise and extensive background in cave and karst science and resource management, and representing a broad range of public and private organizations. Bylaws for this new organization were approved in March 2006. The first official meeting of NCKRI, Inc. was held in May 2006. During this meeting, it was voted to increase the size of the Board to 15 members. The Board met formally again in October 2006 and May 2007. At the May 2007 meeting, Carol McCoy took over as the NPS lead for NCKRI in anticipation of the upcoming retirement of NPS designated official, Dave Shaver, NPS Geologic Resources Division Chief. Details of the NCKRI Board of Directors membership are presented below.

BOARD OF DIRECTORS

Harry Burgess

Harry Burgess 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. Harry has been a board member since 2005, appointed by the Mayor of Carlsbad, New Mexico. Harry holds a Bachelor's degree in Industrial Relations, a Master's in Fire and Emergency Management Administration, and a Master's of Business Administration.

Richard Cervantes

Richard Cervantes 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. Richard has been a board member since 2005, permanent position representing New Mexico Tech. Richard holds a Master's Degree in Accounting and Information Systems, and is a CPA.

Dr. Nicholas Crawford

Dr. Nicholas Crawford is a Professor of Geography at Western Kentucky University in Bowling Green. He is also the founder and Director of the university's Center for Cave and Karst Studies, establishing it in 1979. Through the Center, Nick has provided multidisciplinary karst classes to hundreds of students and professionals, and conducted karst environment impact studies throughout the eastern United States, especially on problems involving karst groundwater quality, sinkhole flooding, and sinkhole collapse. He has been a NCKRI board member since 2005.

Jim Goodbar

Jim Goodbar 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. Jim was a member of NCKRI's Federal Working Group from 2000 to 2005, and a member of the Board since 2005. He holds a Bachelor's degree in Park and Recreation Management, also Graduate Studies in Cave and Karst Resources, Geology, and Geomorphology.

Dr. John (Jack) Hess

Dr. Jack Hess 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. Jack currently serves on the board of the Karst Waters Institute, and Longs Peak Council of the Boy Scouts of America, as well as NCKRI. Jack is a Fellow of the Geological Society of America, the National Speleological Society, and the Cave Research Foundation. Jack has been a board member since 2005, and a member at large of the Executive Committee. Jack holds a Ph.D. in Geology.

Dr. Kathleen Lavoie

Dr. Kathleen Lavoie is a Biologist and a 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. Kathleen has been a board member since 2006. She holds a Ph.D. in Biological Sciences.

Dr. Donald McFarlane

Dr. Donald McFarlane 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. Donald has been a board member since 2005. He holds both a Bachelor's and Master's degrees in Zoology, and a Ph.D. in Ecology.

Hazel Medville

Hazel Medville has been a member of the board of directors since 2005. She has been an active caver since 1965 and has been involved in cave surveys and descriptive cave and karst science since then. She is a member of the National Speleological Society where she has served as a director, committee chairman, and officer for many years; she is a Fellow of the Society and recipient of the William J. Stephenson Award for service to the Society. She is a founding member of the West Virginia Speleological Survey and a member of the Hawaii Speleological Survey. She has also done extensive field work in the caves and karst areas of Wyoming and Colorado. Professionally, she was as a computer scientist developing industrial, education, and government applications as both an employee and a contractor.

Dr. Diana Northup

Dr. Diana Northup 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, she 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. Diana has been a board member since May 2006. She holds a Ph.D. in Biology.

Randall Orndorff

Randall Orndorff 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. From 2000 to 2005 Randy was a member of the Working Group formed by Zelda Bailey, the initial Executive Director for the Institute, to help establish the Institute as a viable national organization. He was elected to the Board of Directors in May 2006. He holds Bachelor's and Master's degrees in geology.

Dale Pate

Dale Pate has been the Cave Specialist (Supervisory Physical Scientist) at Carlsbad Caverns National Park since July 1991. He is also currently in a detail to the National Park Service's Geologic Resources Division for up to half of his time as the National Cave and Karst Program Coordinator. Involved with cave exploration and survey from 1970, he became involved with NCKRI during the early formative years before the passage of the Act creating the Institute. From 2000 to 2005 he served on the Federal Working Group formed by Zelda Bailey, the initial Executive Director for the Institute, to help establish the Institute as a viable national organization. He was elected to the Board of Directors in May 2006.

Geary Schindel

Geary Schindel 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. Geary has been a board member since 2005. He holds a Bachelor's degree in Geology and a Master's degree in Geography.

David B. Shaver

Dave Shaver is the chief of the National Park Service, Geologic Resources Division, which provides national leadership and policy oversight for all NPS geology programs. Dave has been with the NPS since 1979, working in the air quality, mining and minerals, and geologic resource management programs. He became involved with NCKRI following passage of the 1998 Act, when the Division was assigned lead responsibility for the NPS. Dave has served as the NPS Director's designated representative on the NCKRI Board since 2005. He has a Bachelor's in Economics, a Masters in Environmental Studies, and a Law degree (J.D.).

Dr. Jerry Trout

Jerry Trout was a member of the Federal Working Group from 2000 to 2005, and has been a Board member since 2005. 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. He has a Ph.D. in Education.

Dr. H. Len Vacher

Dr. Len Vacher is Professor of Geology at the University of South Florida, Tampa, (USF) where his main role in karst is cheering on the USF Karst Research Group (KRG) and the USF Library's building and hosting of the Karst Information Portal. The KRG is a loose, two-department collaboration of 11 graduate students, four karst-active faculty (Dr. Robert Brinkmann, Dr. Philip Reeder, Dr. Phil van Beynen, Dr. Bogdan Onac) and numerous friends-of-karst faculty. Eight of the graduate students are in Ph.D. programs of either the Department of Geology or the Department of Geography. The subjects of the dissertations range widely: speleothem-paleoclimate; geomicrobiology; management/education; policy; hydrogeology; geoinformation.

BOARD MEETINGS

With the incorporation of NCKRI as a not-for-profit 501(c)(3), the first order of business was hiring an Executive Director. From the resumes submitted, a small group was interviewed. From that group, the search committee selected Dr. George Veni, a consulting hydrogeologist and owner of George Veni and Associates from San Antonio, Texas. Dr. Veni has been an active member of the caving community since 1975 and joined NCKRI as the Executive Director in February 2007.

The May 2007 Board of Directors meeting included a half day session with interested karst researchers from the Kentucky area, where each of the groups highlighted their programs. There was also some discussion of how they can work together and with NCKRI on common goals.

For the 2007-2008 fiscal year, the NCKRI Board decided not to sponsor a visiting scientist. The transition to a new Executive Director and the building of NCKRI headquarters would be distracting to anyone trying to work in the current offices. Instead, they put additional funds into projects such as sponsoring the Karst Waters Institute's (KWI) conference on *Future Directions in Karst Research*, becoming a corporate sponsor of the 15th International Congress of Speleology, to be held in Kerrville, Texas, in 2009, funding a working group at NMT to test a mathematical approach to speleogenesis in Fall 2007, and funding the Speleogenesis website with a goal of fusing the content to the Karst Information Portal. These projects should make a significant input to cave and karst science while the near-term goals of NCKRI are better defined.

The directors discussed membership strategies, fund raising, and a museum in the new headquarters building. They instituted a Karst Stewardship Committee for partnerships with mainly government land managers, and an Education Committee for issues in K-12, undergraduate, graduate, and other programs for the general public. Once KWI has published the outcome of their Spring 2007 meeting on *Future Directions in Karst Research*, NCKRI will be better positioned to build its programs.



Field trip to the karstic Comal Springs, the largest springs in Texas. co-led by Dr. George Veni for the Future Directions in Karst Research meeting, May 2007. Photo by George Veni.

CURRENT FACILITIES

NCKRI currently occupies three offices and a storage room in the Advanced Manufacturing and Innovation Training Center (AMITC) building in the Airport Industrial Park in southern Carlsbad. The approximate 1,200 sq. ft of space is rented for the Institute from the Carlsbad Department of Development (CDOD) through a Cooperative Agreement between CDOD and the NPS. NCKRI supplies and equipment previously stored at the Los Alamos National Laboratory (LANL) offices in Carlsbad were transferred to the AMITC facility for consolidation, and easier inventory and access. Our thanks go to LANL for lending us the space. CDOD is transferring ownership of the AMITC facility to the Permian Basin Regional Training Center, which will honor the existing Cooperative Agreement. The Institute's offices are anticipated to remain at this facility until construction of the NCKRI headquarters building is complete.

NCKRI BUILDING DESIGN

January 2006 ushered in two important personnel changes for the NCKRI building design and construction effort. First, Harry Burgess the new Carlsbad City Administrator joined the primary partner group after the December 2005 retirement of his predecessor, Jon Tully. Harry quickly assumed leadership for the building planning project, which at that time was faced with revising initial plans that had resulted in construction bids significantly over the available budget. This already challenging project was complicated by the unexpected death of Beryl Durham, principal in Durham & Associates, the primary building design firm at that time. The NPS and NMT worked closely with Harry and the City in the ensuing months to restart the design process and develop a plan that fit within existing budget constraints. When negotiations with Durham & Associates failed to reach agreement on a redesign effort and the concept of NPS taking over the design and construction failed due to Federal contracting constraints, the City ultimately contracted with another architectural firm in early 2007 to complete the architectural plans. Thanks to the untiring efforts and leadership of Harry Burgess, by the end of this reporting period the building design process was nearing completion with the preliminary plans agreed to by the partners and construction targeted for 2008.

Conceptual master plan for the Cascades at Carlsbad, where NCKRI Headquarters will be constructed (courtesy of the Carlsbad Department of Development); NCKRI will be located in the building above the left end of the horseshoe-shaped canal.



NCKRI PROJECTS

NCKRI is a young institute but active with several projects. The following pages describe studies and activities NCKRI has conducted directly, with partners, and has sponsored.

Cave and Karst Studies Program at NMT

NCKRI's primary educational efforts have been at NMT under the leadership of Dr. Penelope J. Boston, who continues as Director of the Cave and Karst Studies Program, faculty member in the Earth and Environmental Sciences Department, and adjunct in the Department of Biology. She is also Associate Director of NCKRI working closely with the Executive Director, relevant NMT personnel, and others to promote both the national institute's goals and promote Cave and Karst Studies at NMT. Because of the highly interdisciplinary nature of cave and karst science, Boston interacts with all four groups within the Earth and Environmental Sciences Department (Geology, Geochemistry, Geophysics, and Hydrology). These interactions with other faculty are beneficial to all and help to optimize use of shared facilities. Cave and Karst funds continue to be used to partially support cave and karst analyses on our mass spectrometer for stable isotope studies (under the direction of Dr. Andrew Campbell), a total carbon analyzer, a critical point drier, a microcentrifuge, and a lyophilizer. We have recently received National Science Foundation (NSF) funding to acquire a new Raman Confocal Microscope for joint use. These shared facilities all add to the capabilities of the Cave and Karst program and facilitate interaction with other faculty, researchers, and students at NMT and outside collaborators.

A major focus of the Cave and Karst program at NMT is training of students interested in cave and karst science and management issues. Our current students are summarized below:

Kevin Stafford, Ph.D. candidate – Kevin is working on the Gypsum Plain of southeast New Mexico and into Texas to determine the factors governing the formation of sinkholes and caves in the highly soluble gypsum and other evaporite minerals. This work has important implications for water storage issues, petroleum reservoirs, and potential geohazards. Kevin has one paper in press and another in revision. Two more are in preparation. He has presented three talks this year at meetings in various parts of the United States. Kevin was awarded the American Association of Petroleum Geologists Mimi Atwater Memorial Scholarship 2007-2008 for his work on gypsum karst processes and speleogenesis. He also received a 2007 Geological Society of America Student Research Award for this study.

Laura Rosales-Lagarde, Ph.D. candidate – Laura continues to study a modern, active sulfuric acid-created cave in Tabasco, Mexico in comparison with ancient relict caves in New Mexico. She is investigating the structural geological controls on the water chemistry and hydrology that has resulted in the formation of the caves and sulfur springs. The modern system in Mexico is very similar to the way we believe Carlsbad Cavern, Lechuguilla Cave, and the other 600 known sulfuric-acid hypogene caves in the Guadalupe Mountains were formed. Laura is partly supported by a CONACYT scholarship from the government of Mexico. Laura has presented talks at four meetings this year, two in Mexico and two in the United States. She has one paper in Spanish in press, and her first paper in English is in preparation.

Megan Curry, Master's student – Megan is pursuing the origin of unconsolidated calcite pastes in Spider Cave, Carlsbad Caverns National Park. She is attempting to distinguish the biological from chemical factors that influence this carbonate deposit. This year she traveled to Tongass National Forest in Alaska to sample a currently active analogous cave. By comparing the two site areas in New Mexico and Alaska, she hopes to shed light on the climatic conditions present in New Mexico at the time that the carbonate deposits were laid down. Megan was awarded the prestigious William L. Wilson Memorial Scholarship for 2007 from the Karst Waters Institute for her work on the biological and chemical origins of moonmilk. This scholarship honors the memory of William L. Wilson, a pioneering cave and karst scientist who passed away suddenly in 2002.

Katrina Koski, Ph.D. candidate – Katrina received a 2007 Water Resources Research Institute (WRI) student grant to study a tufa spring mound near Santa Rosa, New Mexico. This unusual spring is depositing large amounts of carbonate that has accumulated in a 15 m wide and 5 m tall mound while all other springs in the vicinity are not precipitating. This curious circumstance could be related to details of the spring architecture and hydrology, a localized carbonate rich layer that may intersect the water flow paths, or even the action of certain microorganisms that may be enhancing precipitation of the mineral. She will be presenting her first results at the WRI conference in August, 2007.

Erin Kay, Master's student – Erin is modeling impact cratering into icy terrain layers and considering whether the rapid release of fluid can leave both a geochemical and physical imprint, possibly including providing preferential fracture pathways for the formation of later caves. She is also investigating whether such events can temporarily provide a geothermal habitat for microorganisms. This work has implications for large impact events on Earth, for example, the event thought to have contributed to the demise of the dinosaurs and other life at the end of the Cretaceous period 65 million years ago. It also has implications for interpreting any similar features on the planet Mars. New Mexico has many terrains used as Mars analogs and she is using those as a basis of comparison to her model results. Erin received a New Mexico Space Grant Consortium 2007 student scholarship to advance this work.

Undergraduate Senior Theses - In addition to the graduate students, four undergraduate students are working on Senior Thesis projects under Dr. Boston's direction: 1) JoAnna Johnston, karst processes in glacial and permafrost terrain, 2) Steven Scholle, urine mitigation for cave exploration, 3) Shari Houston, chemical and biological contributions to carbonate deposition of cave pearl formations, and 4) Brad Christiansen, cave features on Mars using the latest MRO imaging and multispectral data sets.

Visiting Students – This year the Cave and Karst Program has hosted several visiting students for significant periods of time. NASA Planetary Biology Intern, Blaire Steven, was in residence for two months at the NMT Cave and Karst labs. Blaire is a graduate student from Canada in the Department of Natural Resource Sciences, at McGill University in Montreal, Quebec, Canada and is working on extreme microorganisms in permafrost. Andrea Martín-Pérez from the Universidad Complutense in Madrid, Spain, stayed with us for three months. Andrea is a student of Dr. Anna Alonso-Zarza, and is also working on the issues of moonmilk in a Spanish cave. She was supported on a fellowship from the Spanish Research Council. Both students accompanied Cave and Karst program students and personnel on expeditions to a variety of caves in New Mexico, Colorado, Alaska, and Mexico.

Research Experience for Undergraduates (REU) – For the third consecutive year, we are participating in a NSF-funded program that brings 12 undergraduates from all over the country and Puerto Rico to NMT for two summer months to do research with scientists at NMT. Each year, the Cave and Karst Program works specifically with two or three students on a cave/karst related project. Our two students this year are Erica Littlejohn from Chicago, now at the University of Iowa, and Irevis Nieves-Cintrón, from San Juan, Puerto Rico, in school at University of Puerto Rico, Bayamon. They are working on the mineralogy and microbiology of carbonate and iron/manganese deposits from New Mexico caves and lava tubes. Dr. Tom Kieft (Biology Department) and Dr. Andy Campbell (Earth and Environmental Science Department) are also on the mentoring team.

Other Educational Outreach Activities – Dr. Boston is co-investigator on the second year of a NASA-funded project (Spaceward Bound) with Dr. Chris McKay of NASA Ames Research Center, Dr. Robert Zubrin of Pioneer Astronautics, and NASA-Ames Educational Specialist Liza Coe. The science and engineering team took 42 middle and high school teachers from all over the US into the field in the Mojave Desert, California, to study lava tubes, carbonate caves, surface desert soils, and to help control robotics experiments. Teachers participated in experiments to test whether thermographic imaging from aerial platforms (e.g. hot air balloons) is a viable technique to detect lava tube cave entrances and what conditions optimize chances of this. They assisted with geomicrobiological sampling in lava tubes

and helped with mapping surface cryptogamic soils (held together by microorganisms). They broadcast from the field back to their home schools. Dr. Boston presented an evening lecture on the many different types of caves in the world and the basics of speleogenetic processes and the types of animals and microorganisms that inhabit them. This follows on the heels of the first year's expedition in which we took 14 middle and high school teachers to the Atacama Desert in Chile.

For the fifth consecutive year, Dr. Boston presented lectures on cave and karst science, exploration, and the relation to extraterrestrial NASA missions, to the prestigious Summer Science Program for gifted high school students being held at NMT and Ojai, California, and sponsored in part by Cal Tech. Educational outreach to the community of senior citizens is not forgotten, with Boston presenting two short courses on *Caves in New Mexico* and *Geomicrobiology* to the OASIS Adult Education Program in Albuquerque, sponsored by Foley's Department Stores. She also developed a third course on *Biotechnology* presented by a colleague at University of New Mexico (UNM), Dr. Diana Northup. She will be teaching a new course, *Space Exploration and Exploration on Earth*, in Fall 2007.

Research and External Funding

The active research of the Cave and Karst Program continues at a challenging pace, both on the NMT campus and at field sites and with collaborators both at UNM, New Mexico State University, and outside of the state. Work continues with Carlsbad Caverns National Park on cave mineralogy and geomicrobiology research projects in Carlsbad Cavern, Lechuguilla Cave, and Spider Cave, and in other Guadalupe Mountain caves managed by the Carlsbad Bureau of Land Management (BLM) office and the Carlsbad office of the USDA Forest Service, and on projects in lava tube caves of El Malpais National Monument near Grants, and the Valley of Fires near Carrizozo, New Mexico. Cave study sites elsewhere in New Mexico, Colorado, Wyoming, Utah, Alaska, and Mexico are also under active investigation by the team. As a goodwill gesture for our federal partner, the NPS, a service project for Carlsbad Caverns National Park is underway to help it manage the urine disposal issues in Lechuguilla Cave.

A special project concerning Snowy River, Fort Stanton Cave, Lincoln County, New Mexico, has just kicked into high gear. In prior years, we have been heavily involved with the scientific assessment of a newly discovered major world-class cave passage, Snowy River in Fort Stanton Cave, Lincoln County, which is managed by the BLM. The Snowy River formation is the largest known speleothem in the world, a sparkling white calcite deposit over 3 km long (so far) with much more anticipated to be surveyed. It is the subject of protective federal legislation introduced by New Mexico senators Pete Domenici and Jeff Bingaman, which is still pending in Congress. In 2005, Dr. Boston testified in the Senate on behalf of this legislation and its value to the scientific and federal land management communities. NCKRI's Dr. Lewis Land has continued to assist with mapping of these newly discovered cave passages in collaboration with the Cave Research Foundation. Dr. Boston performed the initial microbiological and mineralogical assessment of this world class virgin passage. Access to this feature has been closed for 3 years since a couple of initial trips along an extremely hazardous route, including the science assessment trip with Boston and Land. Excavations to bypass that route should be complete soon. Beyond the beauty of Snowy River, its minerals preserve information that will help us understand the past climate history and hydrology of the region, a topic of immediate present-day concern as we address the potential water resource and other effects of future climate change on the economics and quality of life for the population of New Mexico. Proposals have been submitted to BLM pending appropriations attached to the congressional legislation.

We continue work on the NSF-funded project to analyze the iron and manganese deposits in Spider Cave and Lechuguilla Cave and have applied for an extension through 2008. We are finishing up a joint pilot project with MIT to develop hopping microrobots for gaining access to inaccessible Earth caves and extraterrestrial caves, and to be used in search and rescue operations necessitated by natural disaster or terrorist acts. We have just received preliminary word that a recent proposal to NSF

to work on carbonate pool fingers in Carlsbad Cavern and Hidden Caves, New Mexico will be funded but the budget will be revised significantly downward due to NSF budget difficulties. We are also in negotiation with the Interstate Stream Commission to iron out details of working on a hydrology project in the Salt Basin area of New Mexico, with Boston overseeing karst issues and Dr. Fred Phillips of NMT overseeing the general hydrological science. This will involve two new master's students arriving at NMT Fall Semester, 2007.

Other Cave and Karst Program Activities

The work of the Cave and Karst Studies Program continues to appear frequently in broadcast and print media. In May and July 2006, Dr. Boston appeared in the Discovery Channel's documentary *Mars Underground*, an award-winning look at the science and personalities trying to push forward exploration of the planet Mars. Broadcast on the National Geographic Channel (June and July 2006), *Is it Real?: Life on Mars*, featured Boston in El Malpais lava tubes talking about the microorganisms that inhabit the underground environment and their relevance to the search for life on Mars. Additional broadcast pieces appeared on a BBC documentary about origins of life, and a Channel 4 (United Kingdom) piece on extreme exploration science is scheduled for broadcast later in 2007. Such appearances help to provide high visibility for cave and karst science and protection, NMT, and NCKRI to the public at large.

Dr. Land, together with Dr. Boston, and several New Mexico Bureau of Geology and Mineral Resources colleagues co-organized the New Mexico Geological Society's 2006 Fall Field Conference devoted to the caves and karst features of the Carlsbad region, the Guadalupe Mountains, and the Gypsum Plain area. The event was attended by approximately 150 people from New Mexico, the Four



CAVES & KARST OF SOUTHEASTERN NEW MEXICO

New Mexico Geological Society 
2006

Corners states, and other parts of the country. For these field conferences, the New Mexico Geological Society always publishes a major guidebook complete with scientific papers, mini-papers, and road logs. This was prepared by NCKRI personnel, Cave and Karst Program students, and Bureau personnel with many contributions from relevant scholars. It was produced in advance and distributed to participants at the event, and will have significant post-event distribution for decades afterward as is typical of this publication series.

NMT has long had a caving club for students, faculty, and staff. With the advent of the Cave and Karst Studies Program five years ago, the club has become very much more active. We have now become an officially chartered Grotto Chapter of the National Speleological Society. In conjunction with this, we hosted the Southwest Regional Technical Meeting in December 2006. An entire day filled with scientific, conservation, and exploration presentations was organized largely by the Cave and Karst Program students with help from a few other individuals. Response from attendees was overwhelmingly positive and our grotto has been asked to undertake the organization of the next such event.

JOINT PROJECTS WITH THE NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES

Dr. Lewis Land works for the New Mexico Bureau of Geology and Mineral Resources as a karst hydrologist in their Carlsbad office, and also serves as the Bureau's liaison with NCKRI. Dr. Land is an adjunct faculty member in the Department of Earth and Environmental Sciences at NMT and was granted tenure by the NMT Board of Regents in April 2007.

Dr. Land's position with the Bureau includes a research and service component, the latter involving public outreach and education. In that capacity he has given many public lectures on groundwater and karst. His research program is focused on regional investigations of the extensive karstic aquifers in southeastern New Mexico. Elements of his research include the following topics:

Roswell Artesian Basin

Dr. Land recently completed a three-year investigation of water resources in the Roswell Artesian Basin of southeastern New Mexico, one of the most intensively farmed areas in the state. Agricultural activity in the basin is entirely dependent on irrigation from groundwater stored primarily in the San Andres limestone, a karstic aquifer with well-documented conduit flow and cavernous porosity. Bit drops of as much as 3 m have been reported during drilling operations through the San Andres. Dr. Land's work in the basin has included systematic measurements and analysis of variations in hydraulic head in the San Andres artesian aquifer. These parameters had not been investigated on a basin-wide scale since 1975, yet an understanding of long-term variations in head is essential for the effective management of water resources in the Roswell Artesian Basin. This work was funded by the Pecos Valley Artesian Conservancy District (PVACD), an independent agency of the state of New Mexico. Results of this study will be published later this year as a New Mexico Bureau of Geology Open File Report. An abridged version of this report has been accepted for publication by the Journal of the American Water Resources Association.

Dr. Land has also recently completed an investigation of groundwater residence time in the San Andres artesian aquifer using natural and anthropogenic tracers – essentially, trying to determine the amount of time required for water to flow through the aquifer from recharge areas on the Pecos Slope to discharge areas from karst springs and sinkhole lakes along the Pecos River at Bitter Lakes National Wildlife Refuge. Because wetlands on the Refuge provide habitat for a number of threatened and endangered species, refuge managers have expressed concern about the potential for contamination by oil and gas drilling and other anthropogenic activity in the aquifer recharge area. Estimates of the time required for groundwater, and hence contaminants, to travel through the artesian aquifer vary widely, ranging from as little as four to greater than 100 years, mainly 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 management of water resources and wildlife habitat at Bitter Lakes. This work was funded by the U.S. Fish and Wildlife Service, which manages the Refuge. Dr. Land will present results of this investigation at the annual meeting of the Geological Society of America in November 2007.



Dr. Lewis Land and a support diver, preparing to dive in a sinkhole lake. Photo Courtesy of Dr. Land

VISITING SCHOLAR PROGRAM

From May 2006 through April 2007, the newly formed NCKRI, Inc. hosted its first Visiting Scholar, Dr. Alexander Klimchouk, from the Ukrainian Institute of Speleology and Karstology. An internationally renowned scholar, cave explorer, and scientist, Dr. Klimchouk visited many organizations and educational institutions around the U.S. as an ambassador for NCKRI. Together with Dr. Penny Boston, he developed a plan for an international coalition of national cave and karst organizations worldwide that will be presented by Boston and Dr. Veni to the Bureau of the Union of International Speleology in August 2007. This initiative has several initial partners: NCKRI, the Ukrainian Institute of Speleology and Karstology, the Turkish Institute for Speleology, the Hoffman Environmental Research Institute, Western Kentucky University, the Slovenian Karst Institute, and others. Dr. Klimchouk also produced a major body of work on hypogene speleology that we have published as our first NCKRI Special Paper No. 1. In addition, Dr. Klimchouk worked closely with students from the Cave and Karst Program and continues scientific collaborations with several of them and with Dr. Boston.

DISTINGUISHED LECTURE SERIES

NCKRI's Distinguished Lecture Series in Carlsbad, New Mexico, is a program of free, public lectures presented by distinguished karst scientists, managers, educators, and explorers. Most are scheduled to occur when the lecturers visit Carlsbad for research and exploration. Lecture audiences average about 50 people. Two lectures were given during this reporting period:

- February 22, 2007: Dr. Bogdan Onac (University of South Florida), *Caving from the Crest of the Alps to the Shores of the Black Sea: Caves and Karst of Central and Eastern Europe*
- May 24, 2007: Dr. Hazel Barton (Northern Kentucky University), *Amazing Caves, Amazing Microbes*

PUBLICATIONS

Dr. Alexander Klimchouk, as a culmination of his one-year position as NCKRI's Visiting Scholar, published NCKRI Special Paper No. 1: *Hypogene Speleogenesis: Hydrogeological and Morphogenetic Perspective*. This book, the first in a new series by NCKRI, draws on international examples to firmly establish hypogene speleogenesis as a major and wide-spread phenomenon. This book carefully outlines the characteristics of hypogenic karst aquifers, independent of their varied geochemistry, and provides practical guidance in recognizing such systems through more than 60 figures and 19 pages of color photos. Dr. Klimchouk concludes the book with a chapter that reevaluates karst management problems and economic resources relative to hypogenic processes.

WEBSITE

NCKRI's website saw two developments in 2007. The existing website was removed and replaced with a single web page that explained the Institute's transition to a non-profit corporation, and listed its Congressional mandates and other basic information. Links to the U.S. Geological Survey National Karst Map and the National Speleological Society were provided, as well as information to order Special Paper No. 1. The second development was the creation of a new website. The layout and general functionality were established, and await content to be finalized and posted.

KARST INFORMATION PORTAL

NCKRI is coordinating an important project called The Karst Information Portal (KIP). This is a joint project with the University of New Mexico (UNM), the University of South Florida (USF), the Karst Waters Institute, and the libraries of Los Alamos National Laboratory to create a multi-faceted information connection that will be able to access an enormous breadth of material across both the United States and internationally. A small amount of seed money, ~\$15k, was allocated by UNM to produce a pilot study, and USF placed many of its resources at the disposal of the project, on the order of \$100,000. The preliminary version has been completed and is scheduled to be officially released at a series of upcoming events including the National Speleological Society (NSS) in July 2007, and the National Cave and Karst Management Symposium and at the Geological Society America Convention in October 2007.

In preparation for the KIP debut, two meetings were held in 2007:

1. USF hosted a meeting of many of the KIP stakeholders in Tampa, Florida in January 2007. Todd Chavez provided an impressive discussion of the capabilities of the portal through technology that the USF Library is supplying. Additionally, Todd gave a talk on the results of the user survey of the use of gray literature with many fascinating insights. Roles of the various stakeholders were clarified and discussions were initiated with Dr. Alexander Klimchouk about a partnership with the newly proposed International Cave and Karst Research Institute Network (ICKRIN). Plans for the future were outlined and USF, NMT, and UNM entered into a partnership grant on Dr. Robert Brinkmann's suggestion of a Great Karst Trail. This grant was collaboratively written as a pre-proposal to the National Science Foundation's Informal Science Education competition, but was not selected for full proposal submission.

2. Dr. Penelope Boston, Todd Chavez, Dr. Diana Northup, Dr. Alexander Klimchouk, Dr. Len Vacher, and Dr. George Veni met in Albuquerque, New Mexico to see a preview of the new KIP database in April 2007. They discussed how to roll out KIP (when, where, and who) and how to integrate activities with ICKRIN and the Speleogenesis website.

KIP continues to grow in preparation for its debut. By mid-2007, there were almost 4000 items in the catalog. The number includes mostly references to digital or physical objects and a few actual digital objects. They come from user contributions, the USF Library staff (Todd Chavez and Spencer Fleury), and from Dr. Diana Northup's *Guide to Speleological Literature*, which was ingested by Todd. In addition, the initial collection of oral histories from cave and karst scientists and cavers will begin at the NSS Convention in 2007. It is hoped that eventually many cave and karst library collections, theses, films, photographs, scientific samples, etc., will be available through the KIP.

The scanning electron micrograph (SEM) database in DSpaceUNM was linked to KIP this year. To make the DSpaceUNM database more useful, commenting on images was successfully implemented and is ready for testing. Experimentation with avenues for promoting discussion of images and their content was funded by the Alliance for Innovation in Science and Technology Information. A partnership was formed with Los Alamos National Laboratory librarians to enhance knowledge discovery using SEMs. These efforts will be tested by NMT's Cave and Karst Program students and linked to KIP after testing.

Users have begun to register: one in May and five in June. It is hoped that many more will register following the summer and fall roll-outs. A major challenge in the coming year will be to gain the participation of the international karst community.

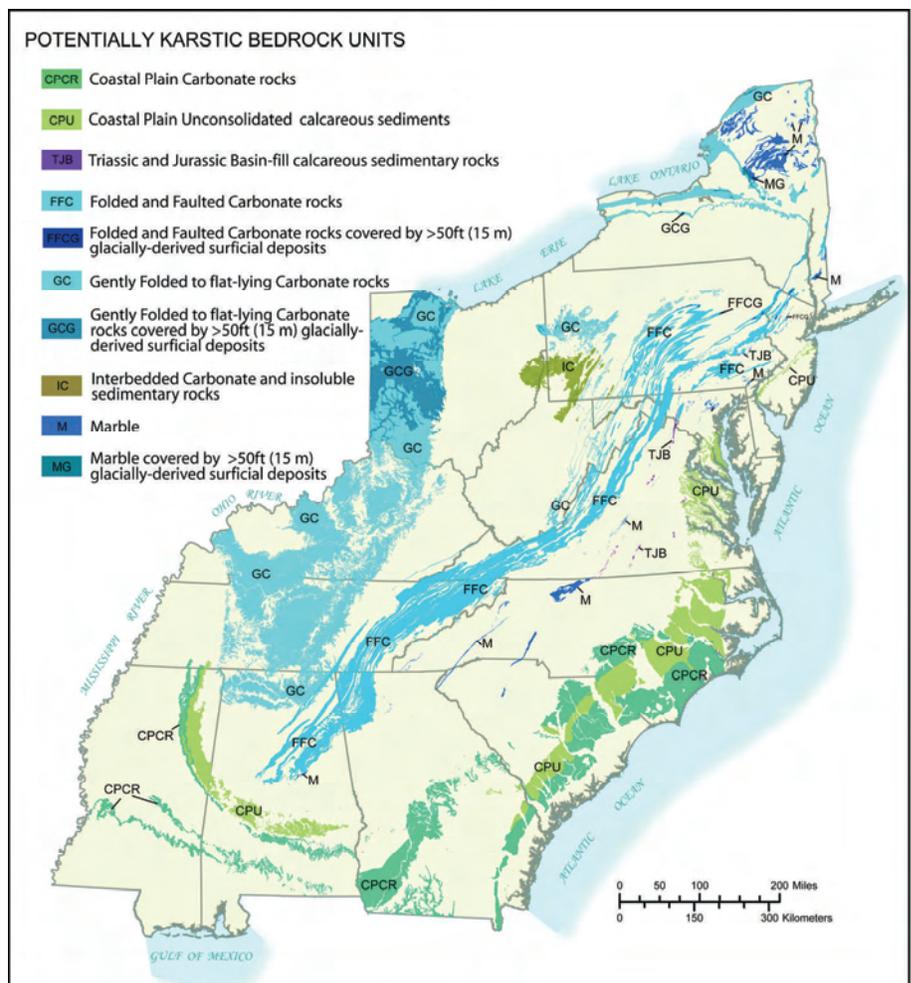
NCKRI SPONSORED PROJECTS

National KARST Map

The U.S. Geological Survey (USGS), in cooperation with NCKRI, is producing a new karst map of the United States. The purpose of this map is to educate the public and Congress about karst issues, to aid Federal and other land-use managers in managing karst resources, and to form the basis for a web-based clearinghouse of karst information. This map will replace the national atlas map of Davies and others (1984, *Engineering Aspects of Karst*, U.S. Geological Survey, scale 1:7,500,000).

A first approximation of karst areas is provided by delineation of soluble bedrock units derived primarily from state geologic maps. The potential karst areas are then subdivided into karst types reflecting regional styles of karstification. Criteria being considered include: geologic setting, physiography, and the distribution and density of caves, sinkholes, and other karst features. Other variables such as ecoregions and the known geographic distribution of cave organisms may also be considered. The current project is geographic information system (GIS)-based and will allow improvements in precision and utility compared to the Davies (1984) map. The map is being compiled in a GIS at a resolution of 1:1,000,000. The new data are generated in several phases based on regions of the U.S. Because of differences in scale and scope, the National Karst Map dataset will have a top-down relationship to other karst databases. This relationship can be thought of as somewhat analogous to the relationship of metadata to data. The Karst Information Portal offers a potential framework for integration of data sets of all resolutions from national to local scales.

As of 2007, the USGS has coordinated with state geological surveys across the nation to delineate karst and karst prone areas. With the support of NCKRI, workshops have been held with Appalachian region states, Rocky Mountain region states, Midwestern States, and Western states with participation from state geological surveys and karst organizations. A karst map of the Appalachian region is expected to be published 2008 with other regions to follow. The national coverage should be available in 2009.



Draft map of potentially karstic bedrock units of the Appalachians and eastern states; an example of a portion of a national karst map being produced by the U.S. Geological Survey. Submitted by Randall C. Orndorff and David J. Weary

NCKRI/WKU PROGRAM FOR GRADUATE TRAINING IN RESOURCE MANAGEMENT FOR FEDERAL LAND MANAGERS: ACTIVITIES 2006-2007

Introduction and Background

Following an extensive history of interactions in science and education between Western Kentucky University (WKU) and the National Park Service (NPS), in 2002 the WKU Hoffman Environmental Research Institute signed a five-year Cooperative Agreement (CA) with NCKRI and NPS with \$20,000 of support to provide graduate level training in resource management, with an emphasis in karst resources, for resource managers in current federal positions. In 2007 the agreement was extended through May 30, 2008 with \$10,000 of additional funds awarded.



The program leads to a Masters of Science Degree in an environmental field from WKU, designed to accommodate resource managers in existing federal career positions in a way that allows them to stay in such positions during the training. Although NCKRI support of the existing program was funded through the National Park Service, the agreement was written to encompass training of federal employees of other agencies as well, for example the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM).

Results

In 2006-07 progress was made in the following activities, each partially funded by NCKRI:

Joel Despain, Cave Specialist for California's Sequoia and Kings Canyon National Parks, received a 2006 MS degree in Geoscience with the successful defense of his Thesis *Hydrochemistry in an Alpine Karst System, Sequoia and Kings Canyon National Parks, California*.

Johanna Kovarik, Geologist with Alaska's Tongass National Forest, received a 2007 MS degree in Geoscience with the successful defense of her thesis *Modeling the Effects of Timber Harvesting on Karst Watersheds in a Temperate Rainforest using Runoff Response Rates, Tongass National Forest, Alaska*

Johnny Merideth, Ranger in the Interpretive Division of Kentucky's Mammoth Cave National Park, continued work on Masters research on vadose zone hydrochemistry within the Mammoth Cave System. Merideth will defend his thesis in 2008.

Dan Nolfi, Biological Science Technician at Tennessee's Great Smoky Mountains National Park, has been accepted into the program and will begin coursework in Spring 2008. His thesis research will investigate spatial distribution of cave resources in the park, and through coursework and independent study he will develop knowledge and skills necessary to develop a park-wide karst resource management plan.

The following presentations were made during this period:

Kovarik, J., C. Groves, S. Kenworthy, J.F. Baichtal, K. Prussian, and A. Meier, 2007, *Storm response and water balance of temperate rainforest karst watersheds: Tongass National Forest, Alaska*. International Conference on Karst Hydrogeology and Ecosystems, Bowling Green, Kentucky.

Despain J., C. Groves, and J. Meiman, 2006, *Hydrology and rock/water interactions of an Alpine Karst System: Spring Creek, Mineral King, Sequoia National Park, California*. Presented at the 8th International Conference on Limestone Hydrogeology, Neuchâtel, Switzerland.

Program Leveraging

Although no cost-share from WKU was required in the CA, WKU has provided additional training benefits to NCKRI, NPS, and USFS through students graduating during this period who were not yet federal employees and thus did not receive financial support from the program, yet either 1) did thesis research on federally owned karst resources or 2) accepted federal government positions in resource management upon graduation, as follows:

Melissa Hendrickson received a 2006 Masters degree in Geoscience. Her thesis was *The Influence of Organic Acid on the Dissolution Rate of Limestone: Beaver Falls-Mop Spring, Tongass National Forest, Alaska* She is now pursuing a Ph.D. in Canada.

Ben Tobin received a 2007 Masters degree and has taken a position as a Physical Science Technician at California's Sequoia and Kings Canyon National Parks.

Andrea Croskrey received a 2006 Masters degree in Geoscience and has taken a position with the NPS Geologic Resources Division in Denver, Colorado.

Outlook

Though the training program continues, the NCKRI/WKU Cooperative Agreement (CA) will expire on May 30, 2008, and is not renewable since NCKRI has moved out from under the NPS umbrella. Discussions are underway to establish new CAs to continue this and other educational programs.

WESTERN KENTUCKY UNIVERSITY – MICROBIAL FILM STUDY

NCKRI funded this microbial study with Western Kentucky University (WKU). WKU conducted the study jointly with Northern Kentucky University.

1. Activities, Progress, and Status

1.1. DNA sequence analysis for identification of bacteria.

Bacterial 16S SSU-DNA sequence libraries were generated from environmental DNA extracted from biofilms formed on the limestone BioSep beads after one year residence at each of the five study sites. Preliminary analysis has been carried out on these sequences to generate phylogenetic trees of the bacterial communities at each study site. Dr. Hazel Barton of Northern Kentucky University will thoroughly analyze the sequences to produce phylogenetic data for a forthcoming manuscript.

1.2. Biofilm Lipid Analysis.

Fatty acid methyl ester (FAME) analysis is a method characterizing membrane lipids to yield data on the biomass, community structure, and physiological status of bacterial communities comprising the cave aquifer biofilms developed on the beads. Lipid analysis results have been delivered and interpreted for the limestone beads. Isotopic data from the beads containing $\text{Ca}^{13}\text{CO}_3$ were forwarded to Michigan State University for interpretation.

2. Problems encountered

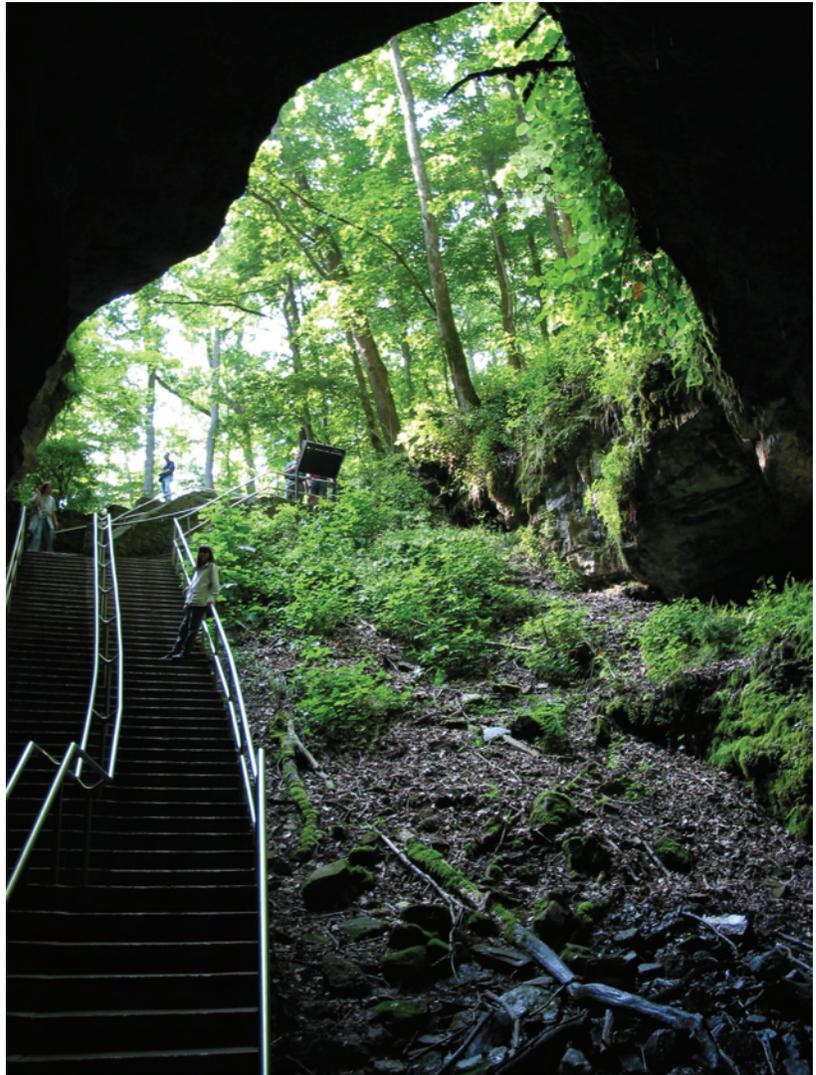
Interpretation of the lipid data was delayed because few people have the specialized skills required, and David Hedrick was recruited to complete the task. The isotopic analysis data, even more difficult to interpret, has been collected but awaits expert analysis. The recent death of the lab director has understandably put the facility in a state of transition at this time (<http://cba.bio.utk.edu>). Negotiations are underway with others in the field for future lipid analyses. All DNA analysis experimental work has been completed and the proposed experiments proceeded without difficulty throughout the project period. Computer analyses of the data will complete that portion of the project.

3. Practical Applications

As part of this study, samples were being collected at Charon's Cascade in Mammoth Cave, Kentucky, for DNA analysis. A full chemical and fecal bacterial workups were conducted because of the unusually heavy rains at the time. Surprisingly, fecal coliform and *E. coli* levels at Charon's Cascade were ten times higher than allowed for recreational exposure. Mammoth Cave National Park officials were notified immediately, and studies of the source of the contamination commenced. Continuous monitoring is providing data concerning the factors that may be causing the problem.

The DNA sequence data from the bacterial communities at the Charon's Cascade site cover October 2000, January 2005, and the day of the contamination event: October 19, 2006. Molecular data will be used to study the impacts and fate of fecal bacteria relative to the natural bacterial community in the cave sediments.

Historic Entrance of Mammoth Cave, Kentucky. Photo: by George Veni.



VOLUNTEERS

NCKRI has been very fortunate to have outstanding volunteers to assist it in many ways and represent it at a variety of projects and events. Their credentials are excellent and they have provided thousands of hours of service towards fulfilling the Institute's mission. However, during the 2006-2007 period of this report, when NCKRI leadership was in transition, volunteer opportunities were limited. Two volunteers assisted NCKRI during this period.

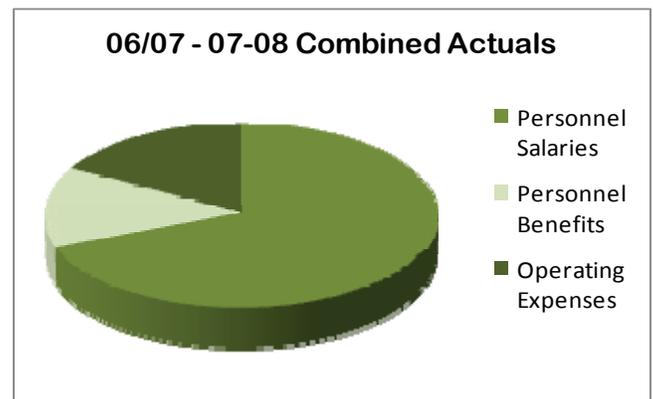
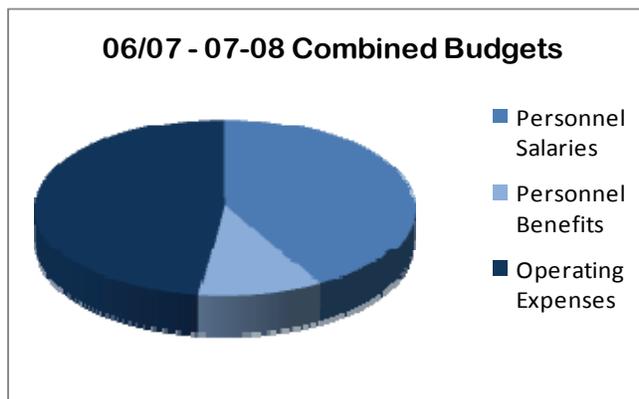
- **Dr. Patricia Seiser**, a Carlsbad, New Mexico, resident, has volunteered hundreds of hours on behalf of NCKRI projects for nearly four years. Among her many contributions during 2006 and 2007 have been to represent NCKRI in Carlsbad during the transition between executive directors, provide important administrative support, recruited and organized public lectures, copy-edited Special Paper No. 1 for Internet posting, and conducted and supported many educational and safety and rescue activities.
- **Rich Wolfert**, owner of Inner Realm Books in Carlsbad, lent his expertise to assist NCKRI in developing strategies for marketing Special Paper No. 1 and future publications.

Financial/Budget

FY 2006-2007 and FY 2007-2008 Budgets

	Federal		State of New Mexico		Combined	
	*FY 06/07 & 07/08 Combined Budgets	FY 06/07 & 07/08 Combined Actuals	FY 06/07 & 07/08 Combined Budgets	FY 06/07 & 07/08 Combined Actuals	FY 06/07 & 07/08 Combined Budgets	FY 06/07 & 07/08 Combined Actuals
PROJECT SALARIES						
Staff	201,110	201,110	276,945	273,050	478,055	474,160
Students			68,000	205,389	68,000	205,389
Project Salaries Sub-Total	201,110	201,110	344,945	478,439	546,055	679,549
FRINGE BENEFITS						
Staff	55,137	55,137	77,835	78,141	132,972	133,278
Students			1,360	4,596	1,360	4,596
Fringe Benefits Sub-total	55,137	55,137	79,195	82,737	134,332	137,874
TOTAL PERSONNEL EXPENSE	256,247	256,247	424,140	561,176	680,387	817,423
OPERATING EXPENSES						
Maintenance Fund/Rent	400	400			400	400
Utilities and Janitorial						
Supplies & Expense	10,293	10,293	145,860	26,949	156,153	37,242
Telephone Equipment Charges			8,000	1,962	8,000	1,962
Travel	9,207	9,207	60,000	51,834	69,207	61,041
Equipment			326,300	2,403	326,300	2,403
Programs	4,307	4,307		-1,540	4,307	2,767
NMT Administrative Support			45,000	45,000	45,000	45,000
NMT "Indirect" from NPS Budget (8%)	9,700	9,700			9,700	9,700
NPS "Indirect" to GRD at 6% on NPS appropriation	7,561	7,561			7,561	7,561
TOTAL OPERATING EXPENSE	41,468	41,468	585,160	126,608	626,628	168,076
TOTAL PROPOSED BUDGET / EXPENSES	297,715	297,715	1,009,300	687,784	1,307,015	985,499

*Several different task orders are in process for each of the two Federal years, the task orders are spread over the two years. It is impossible to determine which part of the budget would be applicable to any one year, so the budgets conform to the actuals.



FUTURE DIRECTIONS: STRATEGIC PLANNING

A strategic plan for NCKRI for 2007-2017 was approved during the May 2007 Board of Directors meeting. Only some of the goals for the next two years are presented below. The goals are presented in a combined order of priority and chronology. The goals are generally described in broad terms, and are not exclusive or described to their full extent. Annual evaluations of progress toward the goals and overarching concepts, such as hiring the best staff, conducting programs of national significance, and promoting good relationship with everyone involved with caves and karst, are understood as included.

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 2007-2008

- Update and establish administrative procedures and resolve remaining questions arising from NCKRI's transition within the NPS to its current non-profit status.
- Hire an administrative assistant.
- Begin construction of NCKRI headquarters (includes development of museum exhibits and the purchase of office and lab equipment).
- Affirm and strengthen ties with existing partners.
- Promote use and development of the KIP.
- Develop lists of potential projects and sponsors/partners for those projects, and begin working with the most likely and/or crucial projects and sponsors.
- Develop partnership with the Carlsbad Caverns/Guadalupe Mountains Natural History Association for the operation of the NCKRI bookstore; begin preparation of NCKRI-specific materials that will be ready for sale when the headquarters is opened to the public.
- Develop job descriptions and select personnel to fill those jobs.

FY 2008-2009

- Conduct high-level national and international PR campaign for fund and partnership building during the grand opening of NCKRI headquarters.
- Begin local karst education series program.
- Begin a national karst education program with curricula for K-12 and universities, and outreach programs for agencies and organizations.
- 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.
- Conduct follow-up *Future Directions in Karst Research Workshop* focused on applied research issues, which will serve as an impetus to...
- Begin a regular publication series for NCKRI, including *Best Practices in Karst Science* to fill a critical need and establish NCKRI as the leader in karst science, *National Report on the Status of Caves and Karst*.

