INSIDE EARTH

A NEWSLETTER OF THE NATIONAL PARK SERVICE
CAVE & KARST PROGRAMS
Edited by Dale L. Pate

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Website Address:
http://www2.nature.nps.gov/grd/geology/caves/newsletter.htm
Webmaster: Jim F. Wood: jim_f._wood@nps.gov

PARK UPDATES

CARLSBAD CAVERNS NATIONAL PARK
by Dale Pate & Paul Burger

AGE-DATING GUANO IN THE BIG ROOM - Pat Jablonsky has submitted a final report on her research of the age of guano from the Big Room in Carlsbad Cavern. The average date from three separate analyses is 45,830 +/- 1366 years before present.

MICROBIAL RESEARCH - At a special session of the George Wright Society Conference recently held in Denver, Dr. Larry Mallory and Dale Pate presented integrated talks on the value of microbes found in caves and how management of Lechuguilla Cave has been affected by microbial research. The National Park Service is currently producing a NEPA document that will address future microbial research within units of the NPS. Because of the large volume of ongoing microbial research at Yellowstone National Park, their resource management staff is the lead on producing this important document.

WATER TANK REMOVAL - With the long-term goal of removing numerous structures from above Carlsbad Cavern, this 500,000-gallon water tank and associated insulated water line was removed during a 9-day period beginning March 22. This is the first of a number of man-made structures that will hopefully be removed and not replaced during the next few years.

NOW YOU SEE IT! The 500,000-Gallon Water Tank on March 17, 2001. (NPS Photo by Dale Pate)

NOW YOU DON'T! The Same Area on April 28, 2001. (NPS Photo by Dale Pate)

CAVE INVENTORY - Since 1996, the park has been managing a complete resurvey of Carlsbad Caverns. One component of the resurvey has been the initiation of a new system of cave inventory. The system has undergone two major revisions, but has now been standardized to be used in Carlsbad Cavern, Lechuguilla Cave, and all of the

backcountry caves in the park. Any new survey in the park will now be inventoried at the same time.

The current resurveyed length of Carlsbad Cavern is 19.6 miles (the official length stands at 30.9 miles and will not change until the resurvey surpasses this length) and includes 5,683 survey stations. Thanks to a great deal of volunteer assistance from Ann Scavarda and Steve Lester, all of the inventory data that has been collected at Carlsbad Cavern have now been entered into the park database. More than 40% (2,285) of the stations have been inventoried and entered into the computer. Now that we know what has been done, the park will begin working with volunteer groups such as the Cave Research Foundation to help inventory previously surveyed stations.

JEWEL CAVE NATIONAL MONUMENT

by Rene Ohms

NEW SUPERINTENDENT - Todd Suess, our new superintendent, arrived March 12. He comes to us from Devils Tower National Monument in Wyoming, where he was the Chief of Resource Management. We look forward to working with him!

NEW INTERN - Ben Miller has joined the cave resources team as the Cave Management Intern. He will be with us through December 2001.

JASPER FIRE - Last August's Jasper Fire burned 83,000 acres in the Black Hills and 90% of the Monument. So far we have not seen any hydrologic effects of the fire, but expect to see increased cave drip-rates and surface runoff later this spring.

The annual bat count was conducted January 10, 2001. A total of 1,143 bats were counted: 708 *Corynorhinus townsendii* and 435 *Myotis sp*. These numbers are only slightly lower than last year. We were happy to see that the Jasper Fire does not appear to have affected the bats' preference for Jewel Cave as a hibernaculum.

ESRI CONSERVATION GRANT - Rene Ohms has received a grant from ESRI for two ArcView GIS extensions, 3D Analyst and Spatial Analyst. She will be developing a GIS program during the coming year.

LADDER REMOVAL - A moldy wooden ladder placed in the Delicate Arch Room more than 30 years ago was hauled out of the cave by Ben, Rene, and Belinda Fox (a JECA interpreter).

LINT TARPS - Rene and Ben are in the process of cleaning the lint tarps along the Scenic Tour route. The tarps capture lint, hair, and other debris that falls through the metal platforms, stairs, and bridges along the tour.

RESTORATION CAMP - We're gearing up for the annual Wind/Jewel Restoration camp, to be held May 7-11. At Jewel, volunteers will work on cleaning frostwork and flowstone and removing tracked manganese from rocks along the tour trail.

SCIENCE - In January 2001 a 4-day trip was taken to the southeastern section of the cave for the purpose of collecting corrosion residue samples and retrieving passive radon detectors. Radon levels at Camp Duh (32.1 pCi/l) is lower than any other recorded site in the cave! Stan Allison from Carlsbad Cavern assisted on this trip.

OVER 125 MILES - The surveyed length of Jewel Cave is now over 125 miles (199 kilometers). We are hoping to plan a reunion this year in celebration.

SEQUOIA AND KINGS CANYON NATIONAL PARKS

by Joel Despain

The cave management program at Sequoia and Kings Canyon National Parks, California remains busy with assessing the karst resources in the two parks. Cave mapping, looking for new caves, cave invertebrate inventories, bat counts, and assisting researchers keeps program staff busy.

We are very happy to have Shane Fryer on board as a volunteer for at least three months. Shane is from Kentucky and comes to us with excellent caving, survey and GIS skills. He is a diligent employee and has initiated several new projects including three dimensional modeling, .jpeg animation rendering, and data base management. See Shane's article on page 5 for more information.

In cooperation with Western Kentucky University and Dr. Richard Fowler, sediment samples from park caves are being analyzed for bacterial DNA. This work will give us an overview of the diversity of microbes found in park caves. To date, sediment samples have been collected in Soldiers, Overhang, Hidden and Clough Caves. Other caves will be sampled later in the year, once melting snow allows us access to higher elevation sites. Samples are collected in sterile tubes, packaged with ice and mailed overnight express for analysis.

In May, Sequoia and Kings Canyon staff will assist Sequoia National Forest, Giant Sequoia National Monument in the creation of new bat friendly gates on two caves. These warm, dry caves are inhabited by

Townsend's Long-eared bats (C*orynorhinus townsendii)* and lie very close to a road and parking area. The National Forest has obtained special funding to construct the gates.

Data on paleontological resources in park caves including written descriptions and photographs was recently compiled for inclusion in a NPS wide assessment of these important animal remains. The most well studied Pleistocene-era bones in Sequoia and Kings Canyon are from a Harlan's Ground Sloth, found in Lange Cave in 1952. Other recent discoveries of bones in several park caves remain unstudied.

Clough Cave passed an important landmark recently. The gates on the cave have remained unvandalized for more than two years. Clough was originally gated in the 1960s, but the gate has frequently been damaged or destroyed and was an ineffective barrier to illegal trespass. To overcome this problem the cave was "double" gated. The first gate, at the entrance was repaired and a second gate was added 10 feet further into the cave. The impact of two gates on the cave's bat population was an important concern for park managers. Both gates are bat friendly and include large horizontal openings. Happily, the cave is now regularly used by several species of bats that successfully negotiate both gates. Besides bats, Clough Cave is the home to at least seven species of endemic invertebrates. This was the first cave documented in the two parks, having been found by William O. Clough in 1852. While it was originally a spectacular cave for calcite formations, most of these have sadly been broken or badly damaged.

WIND CAVE NATIONAL PARK

by Rod Horrocks, Marc Ohms & Matt Reece

We have been placing sample vials at various points throughout Wind Cave to collect water vapor for a stable isotope study being conducted by Dr. Jake Turin. He will also be looking for tritium and chlorine-36. This project is being conducted jointly with a project at Lechuguilla Cave in Carlsbad Caverns National Park.

Matt Reece has continued working on entering the backlog of cave inventory data. He has now entered everything up through February 2000 in his new Access database. Using CaveTools, this data has now been interfaced with the Compass cave survey data and other GIS layers and is available for management and research use. Matt has also accepted a job as a summer cave management technician at Lava Beds National Monument and will be leaving Wind Cave in mid April.

In preparation for redesigning our parking lot in 2004, Matt used ArcView to determine the depths of the ceilings of all passages located below the lot (he used a technique described by Rene Ohms elsewhere in this issue). We found that most of the passages varied from 42 feet to 136 feet below the lot with the deepest point being 222 feet.

Former cave management specialist, Jim Nepstad, spent a week at the park to wrap up his dye-tracing project. He learned that several of his monitoring sites still show some dye four years after first going positive. He will now write up the results of the project for an article in the NSS Journal of Caves and Karst Studies.

We have now completed 11 out of the 21 new quadrangle maps of Wind Cave. We currently have two other quads in production. We are on track to reach our goal of 16 finished quads by the end of the year.

Although the perched lake that sumped the route to the Lakes and the deep point in the cave has now dropped a total of 2 ½ feet since June, this decline appears to have slowed or possibly reversed. This lake would have to drop another two feet to once again allow access to the Lakes section of the cave.

The 2001 Wind Cave Restoration Camp will be held from May 7-11. Volunteers will be staying in the VIP Center for two days before going to work at Jewel Cave for two days.

We have set October 13 for the Wind Cave 100-Mile celebration party. Anyone that has participated in the Wind Cave survey is invited to attend. This event will consist of a slide show about the history of cave exploration at Wind Cave and feature talks from three key explorers. If you are interested in attending the event, contact Marc Ohms at Marc_Ohms@nps.gov (RSVP by 9/15/01 for the catered buffet dinner).

Since the last issue of Inside Earth, the surveyed length of Wind Cave has been increased by 4.42 miles, raising it to 98.12 miles, and maintaining its position as seventh longest cave in the world and fifth longest in the US.

ARTICLES

GIS APPLICATIONS FOR CAVE MANAGEMENT

by Rene Ohms

When I arrived at Jewel Cave in late 1998, one of the first things I noticed was an abundance of data. Our file cabinets were filled with reams of datasheets covering radon, water quality, stream flow, precipitation, barometric pressure, and surface determined locations using radio signals (radio-locations). As time went on and I collected more data, I found myself wondering how this information could be used.

Probably the best way to display and learn from the data that we collect is with Geographic Information Systems (GIS). GIS allows the resource manager to integrate several types of data, create maps and search for relationships. It is an especially useful tool for cave managers who are challenged to manage a resource that is spatially complex and not readily visible.

Using CaveTools, an ArcView GIS extension (GIS software) created by Bernie Szukalski, cave survey data in COMPASS format (cave survey software) can be converted into an ArcView shapefile (a software component). Once this has been done, there is virtually no end to the data analysis that can be performed.

At Jewel Cave, I began by overlaying the cave's passages as represented by line plots on roads, topographic data and aerial photographs. This gave us a much better understanding of where the cave lies and which passages run beneath which surface features. We were particularly interested to see the relationship between man-made structures (such as parking lots) and the cave (See Figure 1).

Figure 1. Example of surface/cave overlay.

Next, I linked the inventory data to the survey data. This allowed us to search the inventory data for any combination of items in respect to cave passage locations. Then these queried items were displayed on the cave line plot map. So far we have seen several expected relationships, such as the presence of dripstone formations beneath drainages. More unexpectedly, many bat scratches are located far from the modern-day cave entrance. This could point to previous entrances that have since been naturally filled.

By integrating the cave radio-location data, I was able to assess the accuracy of the Jewel Cave survey and evaluate the accuracy of the depths determined by the cave radio. (This measurement is subject to large errors.) The surface control point locations were compared to the corresponding in-cave locations, and the distance of offset between the two points (in the X and Y direction) was measured. The greatest offsets (~200 feet) occur beyond a portion of the cave named Cloud Nine, far to the southeast. The direction and distance of the offset is approximately the same for each of these sets of points. Most of the points, especially those closest to the entrance, are offset by less than 20 feet. It appears, therefore, that survey errors are compounding as distance from the entrance increases and that overall, the Jewel survey is quite good.

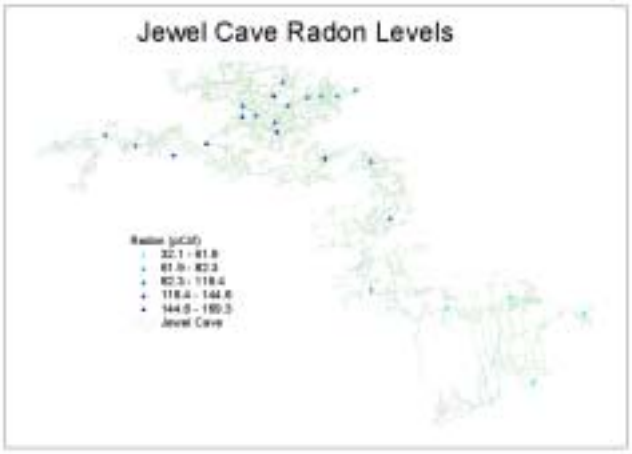
To determine the depth below the local surface for each station, I first joined the surface contour data to the survey data. This gave me the surface elevation above each station, to within 20 feet. The elevation of each station was easily determined by using the known elevation of the cave entrance and the Z coordinates for the stations. Subtracting these two elevations yielded the depth below the local surface. Most of the radio-determined depths are within 20-30 feet of the survey-determined depths. However, a few do not seem to match well at all and are off by as much as 80 feet. This could be due to a weak radio signal during the fieldwork or other ambiguities, which may contribute to an incorrectly determined surface point.

Lastly, I have used GIS to look for patterns in our radon data. Survey stations for which we have data were colored based on the amount of radon detected. More data will be needed before any concrete conclusions can be made, but broadly speaking it appears that there is less radon in the far southeastern section of the cave. This area is the deepest (relative to the surface), and it is also the furthest from the cave entrance. (See Figure 2.)

Virtually any cave data that we collect can be visualized and analyzed using GIS, as long as the data is in some way tied to a real location such as a survey station. Links between very different types of data can be made, and can aid us in

understanding the unique resources we are challenged to protect. At Jewel Cave, we have only begun to examine and apply the relationships that GIS can reveal, and the examples in this article are only the tip of the iceberg.

Figure 2: Radon levels in Jewel Cave.



VOLUNTEERING AT SEQUOIA/KINGS CANYON NATIONAL PARKS: A PERSONAL ACCOUNT

by Shane Fryer

Looking back on the calendar I'm totally boggled to see that I've already been at Sequoia now for a month. I arrived at Ash Mountain, park headquarters, on March 13th and plan to volunteer for 3 months leaving mid-July in time to get back to my home state Kentucky for the National Speleological Society convention. I met Joel Despain during his pursuit of a Masters degree from Western Kentucky University. During his sojourn to higher education, I had the opportunity to play devils advocate, dragging him kicking and screaming away from his studies to do some spectacular caving. While caving we began planning my summer at Sequoia and Kings Canyon National Parks.

For the past year and a half I have been working for an Environmental Protection Agency funded water center, providing technical support for rural public water providers. The majority of my tasks involved using ArcView (a software package) to map MCL (maximum contaminant level) violations incurred by public water systems in the southeastern United States. I have also operated a Geographic Information System (GIS) for karst geophysical investigations and for some dye tracing and ground water basin delineation. This work was excellent preparation for my time at Sequoia and Kings Canyon.

I have 3 major goals to accomplish at the two parks. These are (1) working on an accurate cave location database, (2) developing an internal cave GIS (3) and three-dimensional cave modeling. First Sequoia and Kings Canyon National Parks have over 200 caves and 47 inventoried karst features strewn over an incredibly steep and rugged terrain. Dense chamise, poison oak, and yucca also increase the difficulty of relocating features of interest. Using a Global Positioning System (GPS), topographic maps and aerial photos, we are trying to procure accurate locations. In the past month we've added 49 locations to the list, bringing the grand total to 129 located features. I've then imported these locations into ArcView and associated 27 constituents with the data ranging from temperature, biota, hazard level and resource classifications.

A second project that I've been working on is an internal cave GIS for Crystal Cave and Hurricane Crawl Cave. Joel has drafted incredibly detailed maps of these caves using Corel Draw (another software package). With these maps in a digital format, polygons, lines, and points can be converted to CAD based (yet another software package) DXF files, which can then be registered to a coordinate system. Though working from two-dimensional maps, individual polygons, lines and points will be given a third dimension value which will allow individual formations, biota plots and passages to be accurately located by elevation as well as latitude and longitude.

Finally I'm rendering computer-generated three-dimensional cave models. These models are rendered from DXF files, scaled and geo-referenced to line plots imported into ArcView using Cave Tools (more software). The models include passage lengths, ceiling height and wall distances. I'm also looking into a number of programs that can apply passage profiles to the models. Data, such as temperature and humidity, can be appended to the model. I can also identify passages as vadose, phreatic and phreatic with vadose reworking. These models are very strong interpretive tools allowing the visualization of trends and sequences of formation.

The above mentioned data products are going to be very useful tools. During my volunteer time under Joel, we will analyze trends in cave temperatures across varied elevations and climates. These trends can be correlated to elevation and outliers will be closely examined. We will study the relationship between invertebrate distribution and substrate. We will also look at the proximity of broken formations to the tour route in Crystal Cave.

I'm excited to be at Sequoia and Kings Canyon National Parks and hope to accomplish a lot.

CONTRIBUTORS

Paul Burger
Carlsbad Caverns National Park
3225 National Parks Highway
Carlsbad, New Mexico 88220
Phone: 505/785-2232, ext. 394
Email: paul_burger@nps.gov

Joel Despain
Sequoia National Park
Three Rivers, California 93271
Phone: 209/565-3341
Email: joel_despain@nps.gov

Shane Fryer
Sequoia & Kings Canyon National Parks
Three Rivers, California 93271
Phone: 209/565-3341
Email: shane_fryer@nps.gov

Rod Horrocks
Wind Cave National Park
R.R.1, Box 190
Hot Springs, South Dakota 57747-9430
Phone: 605/745-1158
Email: rod_horrocks@nps.gov

Marc Ohms
Wind Cave National Park
R.R. 1, Box 190
Hots Springs, South Dakota 57747-9430
Phone: 605/745-1158
Email: marc_ohms@nps.gov

Rene Ohms
Jewel Cave National Monument
RR1, Box 60AA
Custer, South Dakota 57730
Phone: 605/673-2288
Email: rene_ohms@nps.gov

Dale Pate
Carlsbad Caverns National Park
3225 National Parks Highway
Carlsbad, New Mexico 88220
Phone: 505/785-2232, ext. 368
Email: dale_pate@nps.gov

Matt Reece
Wind Cave National Park
R.R. 1, Box 190
Hot Springs, South Dakota 57747-9430
Phone: 605/745-1158
Email: matt_reece@nps.gov