



# INSIDE EARTH

A Newsletter of the National Park Service Cave & Karst Programs

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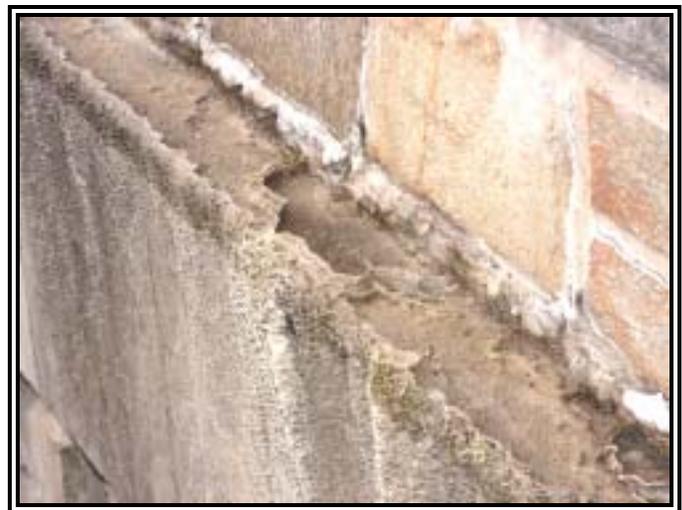
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## THANKS TO DALE PATE

Back in 1998 when we began this newsletter, Dale Pate, cave resource specialist at Carlsbad Caverns National Park, agreed to become the publications first editor. Dale has done an excellent job of editing the newsletter, getting his colleagues to submit papers, articles and updates and put up with the short attention span of the national cave management coordinator who always seems to be going to submit something to the newsletter "tomorrow". Dale has performed the duties of editor with great professionalism, courtesy and grace over the last 5 years. He stills edits Carlsbad's on "Canyons and Caves" and continues his commitment to the cave and karst resources of Carlsbad Caverns National Park. Thanks Dale for all your hard work!  
Ron Kerbo



"Roadside Speleothems. Mineral deposition across the street from the Watergate Hotel, Washington, D.C. (photo by Ronal Kerbo)

## FEATURE ARTICLE

### Dust Deposition along the Candlelight Tour

Wind Cave National Park

By Marc Ohms

#### INTRODUCTION

Wind Cave's Candlelight Tour route is located in the southeast corner of the Historic Section, along the eastern edge of the known cave. With respect to the surface, it lies beneath the large hill behind the Visitor Center. Being under the hill, this area of the cave has a thick overburden, which impedes water from entering the cave and results in this section being extremely dry. The tour route has been modified to accommodate visitors but does not have a continuous concrete path or electric lighting, although there are several concrete stairs and metal handrails. Visitors use

a candle bucket to light their way on the tour. The tour runs twice a day from June to September with a maximum tour size of ten participants and one ranger. During the summer of 2002, there were 166 tours with a total of 1,446 visitors. Park staff has noticed an accumulation of dust along this route that is likely to be unnatural. Although dust deposition in off-trail areas of the cave occurs, it does not appear to be at the same magnitude as the Candlelight Tour route. The floor along this route consists of the disturbed natural sediment or bedrock floor.



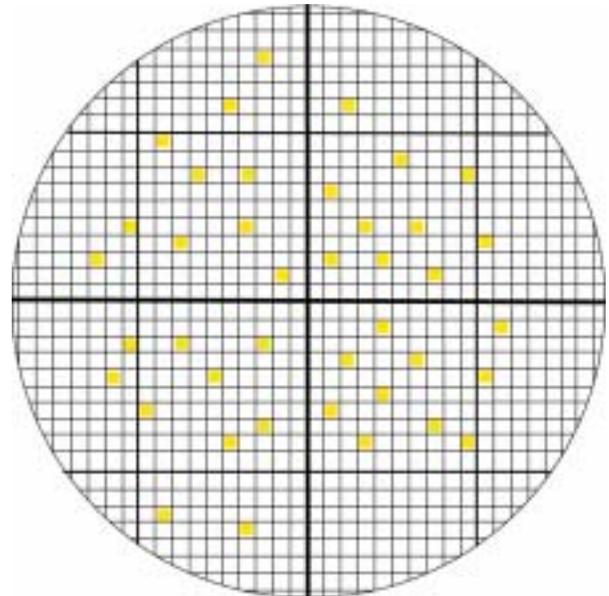
**Figure 1.** The Candlelight Tour- note the dust accumulation on the walls.

#### METHODS

To determine when the dust is being deposited, two series of three petri dishes were placed in three locations along the route. The first series of dishes were installed on December 5<sup>th</sup>, 2001 and removed on April 23<sup>rd</sup>, 2002. Since it is possible that the dust is natural deposition from airflow in the cave, this series of dishes was used to determine dust accumulation levels during the time when no tours were given. This determined the background level of the experiment. The second set of dishes were installed on April 23<sup>rd</sup>, 2002 and removed on September 24<sup>th</sup>, 2002. These dishes were placed in the exact locations as the first set. Therefore, this series yielded data for an entire season of tour use.

To determine the level of dust deposition, the dust particles were counted on each dish. Using graph paper (*10 squares per linear inch*) a template was created (*see figure 2*) on

which the dish was divided into four quadrants. Ten squares were then selected in each quadrant, which were used to count dust particles for all samples. The number of dust particles reported is the total for the 40 squares counted. A microscope was used to magnify the samples in order to increase accuracy in the counting procedure.



**Figure 2.** Dust counting grid

#### RESULTS

One of the summer dishes was disturbed and was unable to be used. The corresponding winter sample was therefore not used. The winter samples indicate that there is indeed natural dust deposition occurring. However, during the summer months the number of dust particles that accumulated on the dishes was 10 times higher than that of the winter samples. The winter samples averaged 161 particles while the summer samples averaged 1,605 particles. Since the airflow within the cave is dictated by changes in the atmospheric pressure rather than seasonal temperature fluctuations, the only difference between the two sample sets is the addition of the tour during the summer. Therefore, it can be concluded that the tour traffic is the source of the additional dust accumulation.

The representational 40 squares used for the sample total .32 square inches in size, approximately the size of a nickel. There were 166 tours this summer with a total of 1,446 visitors. The average tour deposited 8.7 dust particles per nickel-size area ( $1,605 \text{ total particles} - 161 \text{ natural background level} \div 166 \text{ tours}$ ) with an average of .9 dust particles per person ( $1,605 \text{ total particles} - 161 \text{ natural background level} \div '1,446 \text{ visitors} + 166 \text{ rangers}'$ ).

The dust particles on the winter samples were very small grains. By comparison, the summer samples contained particles of various sizes, from very small as found on the winter samples, to much larger particles. This would indicate that the natural airflow cannot carry and deposit the larger particles. Even though the difference between the number of particles from winter to summer is quite

substantial, if the samples were weighed, the difference would be even greater due to the difference in particle size.

The rate of visual degradation by dust fall of the cave is imperceptibly slow, so a cave manager may be unaware that damage is occurring (Neville Michie 1999). Michie states that ten years is the time scale for serious degradation.

SAMPLE NUMBER	VALUE
S1	1887
S2	935
S3	846
S4	1189
S5	1544
S6	2648
S7	2158
S8	1632
W1	148
W2	181
W3	173
W4	164
W5	218
W6	123
W7	131
W8	151

**Figure 3.** The raw data- S= summer, W= winter

#### POTENTIAL IMPACTS

The next step is to determine what impact dust is having on the resources. There are several resources that could be affected- cultural, geological, biological, and visitor satisfaction.

**Cultural-** Dust accumulating on cultural artifacts can affect the resource in several ways. When dust accumulates on fragile resources such as newspaper and string the dust holds additional moisture, which causes the paper or string to deteriorate more readily. Thick dust accumulations will cover historic signatures making them unreadable.

**Geological-** Since this area of the cave is dry, dripstone formations are absent. However there is a wide variety of evaporate mineral deposits such as gypsum, aragonite, and hydromagnesite. These mineral deposits are extremely fragile and a layer of dust could impede their growth or even break them due to the weight of the dust.

**Biological-** Due to the great distance of this area from the Natural Entrance, there are no known vertebrates that live in or routinely use this section of the cave. However, research conducted in nearby areas of the cave has found a diverse presence of micro-invertebrates and microbes (Renee Jesser 1998). The unnatural dust accumulation could have an effect on their presence, population levels, or diversity.

**Visitor Satisfaction and Health-** If resources along the route are being damaged, destroyed, or hidden by dust, visitors are not being provided with a quality visitor experience. Michie (1997) discovered that the smaller dust particles will remain

airborne for several days before settling out. Since we conduct tours on a daily basis, we are creating an environment that has a perpetual "dust cloud" in which employees and visitors must breathe.

#### RECOMMENDATIONS

Once we determine what resources are being impacted and at what level, the park must decide if these impacts are acceptable or an impairment. If we deem it impairment we must take action. Following are a set of options the park can pursue to reduce or eliminate the impact of dust on the Candlelight Tour. Consultation with other divisions may yield more solutions than those listed here.

Option 1- Discontinue use of the Candlelight Tour route.

Option 2- Reduce the size or frequency of the tour.

Option 3- Add a concrete pathway through the dustiest areas.

Option 4- Conduct yearly mitigation of the dust along the route.

#### TRANSFERBILITY AND FUTURE RESEARCH

Now that protocols and methodology have been established for determining levels of dust accumulation, research will be conducted in other areas of Wind Cave. This will include the paved tour routes; the Caving Tour, off-trail recreation routes, and off-trail travel routes used for exploration and research.

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## PARK UPDATES

### **New Lanterns for Resource Protection**

Jewel Cave National Monument

By Rene Ohms

The Historic Area of Jewel Cave has never been electrically lighted. Tours by lantern-light have been conducted since the turn of the last century, along two routes. The first lanterns used in the early 1900s were gasoline lanterns, which were later changed to kerosene lanterns. Concerns about the safety of the fuel prompted a switch to candle lanterns in the

1970s. Borrowing from the design used at nearby Wind Cave, a modified paint can was chosen, with a hole cut in the bottom for a candle.

The paint can lantern (photo 1) provided a safe, bright light, but allowed wax to drip onto the cave floor. Wax dripped out the front, and also through the bottom hole around the candle. When the candle was allowed to burn down too far, the stub would fall through the hole, and it was left in the cave if it could not be located.

After many years of wax accumulation, it became clear that this was a resource problem. The wax grew mold, altering the cave ecosystem and creating an unsightly and potentially unhealthy environment for park visitors (photo 2).

The 2002 Restoration Camp crew worked on scraping wax and mold, and finished cleaning about half of the most heavily used route. Earlier that year, research into new lantern models was begun, taking into account the needs of both resource management and interpretation.

A new lantern has now been chosen and will be used when the tour begins for the 2003 summer season. The lanterns have the historic look of kerosene lanterns, but burn smokeless paraffin oil (photo 3). The Restoration Camp crew will again work on removing wax and mold this year, and the goal is to complete the project along both routes.



Photo 1. Paint can candle lantern used at Jewel Cave for over 20 years. NPS photo



Photo 2. Molding wax in Jewel Cave's Historic Area. Note the candle stub left-center. NPS photo.



Photo 3. Paraffin oil lantern, which will be used starting June 2003. NPS photo.

## Sequoia and Kings Canyon Cave Management Program Update

Joel Despain and Shane Fryer

The Convention of the National Speleological Society will be held August 4th through 8th in nearby Porterville, California with many caving trips occurring within the parks. In total, at least 14 separate caves will see visitation from upwards of 300 cavers during the convention. In order to minimize impacts to park caves, the cave management staff has worked closely with convention organizers and volunteer trip leaders. Multiple days have and will be spent flagging trails in caves and posting signs. Some sections of caves, such as Soldiers, will be closed for convention and new boots and gloves off areas have been designated following restoration work in Crystal Cave. Also a great deal of time and effort has been placed on preparing the conventions web site. Park staff has focused on providing cavers with information that promotes safety and cave conservation. The web pages can be seen at <http://www.nss2003.com/cavetrips/index.html>

Dr. Jean Krejca will be working in two parks under contract to conduct an invertebrate inventory. Krejca's work is being funded by a grant from the NPS Western Regional office and will continue for two years. She will be in the two parks for three weeks in July and August and again in September to complete collections in more than a dozen park caves. Long-term collected animals will be distributed to many taxonomists for identification and the park hopes to develop monitoring protocols and a species keys with Krejca's help.

Other caving events at Sequoia and Kings Canyon this year include Friends of the Pleistocene (FOP), an annual

geology fieldtrip that will focus on Sierran caves and karst and also, the Cave Research Foundation (CRF) Annual Meeting. The FOP field trip will bring 150 geologists and students to the park in early October and the CRF meeting will be held in mid-November.

So far this year we have added 5 new caves to the parks inventory bringing the grand total in Sequoia and Kings Canyon to 221 known caves. Though none of the caves were very extensive they were all found on previously un-checked marble blocks. Both areas contain springs and active streams and hold potential for future finds.

Recent redefining of the parks boundaries have also added a few known caves to the parks inventory. Of particular note is Empire Mine an extensive unsurveyed cave thought to be on private land until recently that was mined starting in the 1870's. The cave contains many cultural resources related to that mining era, and perhaps is one of the deeper known caves in the park.

A new book on park caves, *Hidden Beneath the Mountains The Caves of Sequoia and Kings Canyon National Parks*, has been written by Joel Despain and will be published by Cave Books. The book features dozens of scenic photos by some of America's best known cave photographers and detailed information on the history, wildlife, geology, and beauty of the caves of the parks. It will be available from book vendors in September.

## Lava Beds National Monument

Matt Reece and Kelly Fuhrman

We're getting geared up for another busy summer here at Lava Beds. We have lots of projects in the works, and hopefully enough time to get to them all!

**New Chief:** First things first, after nearly two years chiefless, we'd like to introduce everyone to David Larson, the new Chief of Resource Management here at Lava Beds. David comes to us from Amistad, and has been a great addition to the division.

**Mushpot Cave redevelopment:** Mushpot Cave, the only lighted, self-guided lava tube at Lava Beds, is currently undergoing a redevelopment/restoration project. The project is being conducted to improve visitor experience, and reduce resource impacts on the cave environment. A new lighting system has been designed with the assistance of NPS Cave Lighting Specialist, Rod Horrocks. This system incorporates 12 volt feature lights to control algae growth and improve interpretation of the cave for visitors and trail access lighting for visitor safety. A new concrete trail is being installed with curbing to collect material transported into the cave by visitors.

**Cave Recon/survey:** We've recently recorded cave number 500 in the monument. There's still more than 3500 acres to be checked, so we're confident that we'll be adding more caves to the list in the near future!

**USFS Cave Inventory:** We're continuing to assist the Klamath and Shasta-Trinity National Forests in Northern

California with cave inventory work. Currently, we're finalizing final reports for 3 caves, and hope to get out to inventory a few more caves this summer. The Shasta Area Grotto has provided invaluable assistance throughout this project, and we greatly appreciate their help.

**Visitor Center Relocation:** Construction on the new VC, parking lot, and cave loop access road has begun, and should all be complete by late summer. The Interp division is very anxious to move in to their new digs, and we're anxious to see the old VC complex go so we can rehab it.

**Research Center:** The Lava Beds Research Center is still in the works. The pad area has been completed, and they're hoping to have the building up by winter.

**Cave Management Plan Update:** The revision of the 1990 Cave Management Plan has been drafted, and we're making progress with the EA. We hope to have a completed draft for review by fall.

**Monitoring:** Our bat hibernacula counts are in for the winter, and we've begun our monitoring of our maternity colonies. We will be conducting a project this summer using thermal imaging technology to accurately estimate our Brazilian Free-tailed maternity colony. Dr. Tom Kunz of Boston University will provide the equipment and services for this field work. This study will augment the ongoing population dynamics research of this colony being conducted by monument staff, and we hope to perhaps use it to refine our past estimates.

**CRF Projects:** In addition to cave survey, the CRF is continuing the cave monumenting, ice level monitoring, and entrance photography projects.

## Wind Cave National Park

By Rod Horrocks

Cave Resource Management at Wind Cave National Park has been busy, recently finishing one funded project and starting two others. Some of the related highlights that have occurred at the park since the last issue of Inside Earth include:

The first phase of a funded Cave Restoration Project along the tour routes in Wind Cave was completed. During this project, we were able to restore a section of the developed trail from the Assembly Room to the Methodist Church along the Natural Entrance Tour Route (0.37 miles along that route). Our seven-person crew removed a total of 36 tons of trail construction debris during this six-month project (see associated before and after photos). This project resulted in the refinement of cave restoration techniques used in Wind Cave, development of better photo and artifact log sheets, an estimate of the total tonnage of debris remaining along all cave tour routes, and identification of the process needed to complete the restoration of the remainder of the developed cave.

We recently found and documented another cave in the park, bringing the total number of caves, including Wind Cave, to 26. Marc Ohms is now in the process of preparing for a six-month Cave & Karst Inventory of the entire park for 2004. We will be hiring one physical science and one biological science technician for this upcoming project.

Marc has started a project to monitor unnatural heat inputs in the developed sections of Wind Cave. The potential artificial heat sources he is monitoring include, electric lighting and equipment, artificial entrances, candlelight tours, and visitors.

Rod recently found a couple new speleothems types in Wind Cave while doing volunteer survey work. These include a 16" long coiled gypsum rope and some black needles with interconnecting web-like structures that appear to be biological in origin. The diversity of speleothems types in Wind Cave is certainly another criterion that makes Wind Cave a world-class cave.

Dave Schnute recently donated the first pictures the park has in its collection of Herb and Jan Conn's exploration in Wind Cave between 1963-1968. Some of the more famous landmarks these early explorers discovered included the Spillway (which led to the majority of the cave), Club Room (one of the largest rooms), and Calcite Lake (a series of lakes at the water table and deep point in the cave).

We have completed the revision and updating of 11 of the 21 Wind Cave quadrangles (each of which covers a 1,500' x 1,000' section of Wind Cave) and have started on the 12th and 13th. The drafting of the remaining eight unfinished quads has recently been contracted out. These new contracted quads will include a separate sheet for each of the three major levels of the cave (lower, middle, & upper) and then a combined layer that includes all three levels.

Rod recently participated in the Cave Ecosystem Workshop held at Mammoth Cave National Park. This group of cave management specialists, inventory and monitoring people, and researchers identified the energy conduits into caves, energy sources, natural drivers of cave ecosystems, and threats to caves and karst. Due to the diversity of cave types in the Service, they were only able to identify a few national vital signs that could be monitored at all NPS caves. The group decided to develop an all-inclusive master list that could be drawn from when developing an inventory and monitoring program at each individual park.

The Park will be celebrating its 100<sup>th</sup> birthday on June 13-14. For this event we have created a timeline of the parks history (1881-2003) that also documents the significant discoveries and exploration milestones from the survey of Wind Cave.

Since the last reported length of Wind Cave within Inside Earth, volunteer cavers have increased the surveyed length of the cave by 2.08 miles, establishing the current length of 108.10 miles.



**Photo Caption:** A before (top) and after (bottom) photo taken during the recently completed cave restoration project in the Leenas Arbor area along the Natural Entrance Tour Route. Photos by Matt Reece and Bonnie Curnock.

## ARTICLES

### **Cave Karst Institute Developing at a Rapid Pace**

Submitted by Roger Scott

National Cave and Karst Research Institute

The National Cave and Karst Research Institute, established by Congress in 1998, has been quickly developing and gaining support in its mission to further the research, education, and wise management of cave/karst terrains throughout the United States and around the world. While the National Park Service (NPS) was designated as the lead agency for establishing the organization, the Institute, as its enabling legislation mandates, is now expanding and developing relationships with other partners who are providing both funding and project opportunities.

Dr. Louise D. Hose, the Institute's first permanent director, explained that over the past year a working group of several federal agencies with cave/karst expertise helped lay the groundwork for the Institute. "While we're still in the development stage," she said, "much of the organizational structure has been defined and we are growing and gaining momentum."

As an example she points to a Memorandum of Understanding (MOU) to facilitate the development and

management of the Institute that was signed recently by the National Park Service, the City of Carlsbad and the New Mexico Institute of Mining and Technology. They are the three primary partners involved in establishing the Institute and all have been very active and supportive in providing the seed money and foundation on which to build the Institute.

Their biggest effort to date has been securing \$4.5 million for the design and construction of a headquarters building that will serve as visitor center, laboratory, library and offices for the Institute. In early May, Beryl Durham & Associates and Studio D Architects were selected to negotiate for the design and construction the facility which is being touted as the "anchor" building for the city's major riverfront re-development effort. Ground breaking, on land donated by the city's Department of Development, is tentatively proposed for mid-2004 with building completion sometime in mid to late 2005.

"Our primary goals for the next two years," said Director Hose, "are the design and construction of the headquarters building, continued outreach to help us define our organizational structure and the Institute's vision, and the development of a five year plan. "Achieving these goals will bring credibility and focus to the Institute," she said, "but I think it also illustrates the synergy that diverse partners can bring to the Institute's efforts."

Another initiative Dr. Hose is working on involves more than 20 academic and scientific organizations developing a potential collaboration effort towards a National Science Foundation grant proposal. The grant, if awarded, would provide up to \$4 million a year for 10 years to establish a Science and Technology Center at the Institute. It would also develop the National Cave and Karst Research Institute into a well-funded, first-rate facility within a few short years.

A Vision Workshop is also being explored that would bring together many of the key potential partners who have a stake in the National Cave and Karst Research Institute. Through a facilitated process, the ideas, concerns and needs of all the involved parties would be addressed and shaped into platforms on which to build the institute.

The Institute currently has a professional two-person National Park Service staff (one permanent) and is working on hiring another full-time person. Approval has been given to fill a Chief Scientist position that could be selected by mid-summer 2003. Several folks in the Geologic Resources Division of the NPS also provide a bout 10-15 hours per week of assistance to the Institute. There are also two full-time, partner scientists. An affiliated academic program at New Mexico Tech, one of the Institute's formal partners, is growing and will bring in several new Cave and Karst Studies graduate students next fall.

Dr. Hose, who has an extensive background in speleology and cave exploration, is optimistic about the future of the  
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Institute. "I believe the cave and karst community has an incredible opportunity to advance cave and karst research, education, and management by pulling together in this effort. I want to ensure that everyone has a chance to contribute."

*For more information on the National Cave and Karst Research Institute log on to the NCKRI web site at [www2.nature.nps.gov/nckri](http://www2.nature.nps.gov/nckri). If you would like to receive the Institute's monthly update or have a question, send an e-mail to [nckri-mail@cemrc.org](mailto:nckri-mail@cemrc.org).*

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