

**NATIONAL
SPELEOLOGICAL
SOCIETY
PROGRAM**



**Fifty-First Annual Convention
June 18-25, 1994
Brackettville, Texas**

8 AM 9 10 11 12 M 1 2 3 4 5 6 7 8 9 10 PM

SUNDAY

WALTZ AROUND TEXAS * p11

GREEN CAVE
BAT FLIGHT p11

MONDAY

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	ARCHAEOLOGY SYMPOSIUM OCW p13	U I S ARCHAEOLOGY LUNCH OCE p14	CHILI COOKOFF p15
	BOARD OF GOVERNORS MEETING OCE p14	CLOSED B O G MEETING BR p14	HOWDY PARTY p15
		PHOTOGRAPHY LUNCH SE p14	
	L E A R N COORD. COMM. MEETING SW p14	LAVENDER CAVERS LUNCH SW p14	
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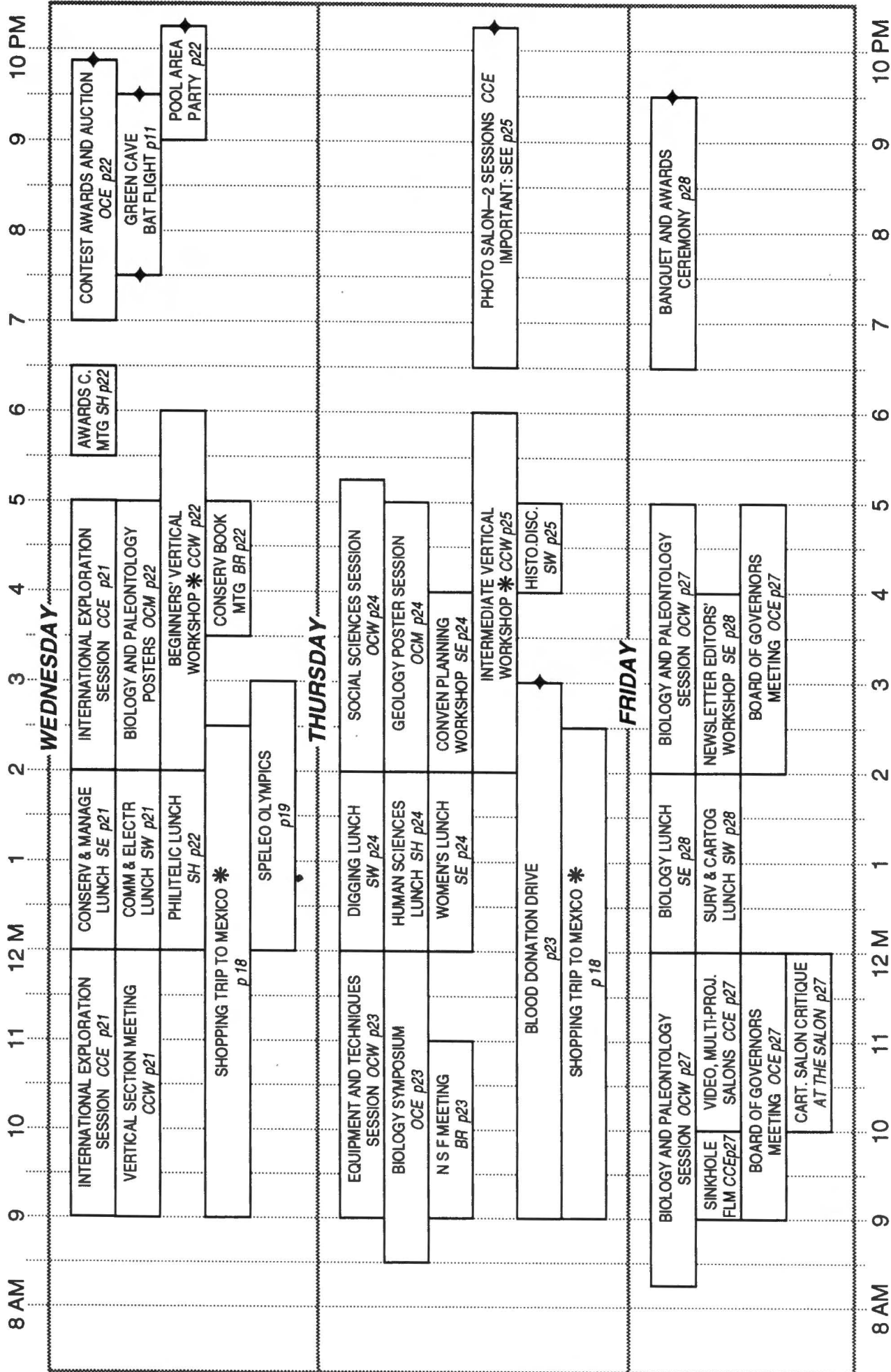
KEY TO ROOMS

- BR Fort Clark Springs Board Room
- CCE Civic Center East Room
- CCW Civic Center West Room
- OCE Old Commissary (second floor) East Room
- OCM Old Commissary (second floor) Middle Room
- OCW Old Commissary (second floor) West Room
- SE Salon Building (second floor) East Room
- SH Shafter Hall (west end of registration bldg.)
- SW Salon Building (second floor) West Room

NOTES

- * ADVANCE REGISTRATION AND FEE PAYMENT REQUIRED
- ◆ TIME VARIES OR INDEFINITE OR OFF SCALE
(in either case, see text on indicated page)

8 AM 9 10 11 12 M 1 2 3 4 5 6 7 8 9 10 PM



F **T** **W** **T** **M** **S**



OFFICIAL MEMORANDUM
STATE OF TEXAS
OFFICE OF THE GOVERNOR

There are approximately 3,000 known caves in Texas, many of which are valuable as habitats for bats and other animals and are widely used to naturally and artificially recharge the Edwards Aquifer.

The National Speleological Society (NSS) and its regional organization, the Texas Speleological Association (TSA), have played an active part in the encouragement of exploration, study and conservation of the caves of Texas for more than 50 years. That encouragement has made it possible to bring together members who share a love for caves and a desire to protect the underground wilderness for future generations.

With a broad range of professional expertise among its membership, the NSS has worked to promote the advancement of education and general public awareness of the value of Texas' cave resources. NSS has also made great strides in the areas of solving cave conservation problems, has initiated legislation to protect fragile cave environments and has helped to make other, less sensitive caves available for educational and recreational purposes.

During the week of June 20-24, 1994, the NSS will hold its annual National Convention at Fort Clark Springs in Brackettville. Hosted by the cavers of Texas and by the Texas Parks and Wildlife Department, the convention will include cavers, scientists and other explorers from across the nation and around the world. The people of Texas recognize that this convention is an important opportunity to showcase our large variety of cave and karst resources, and a way to introduce a large number of visitors to the historical and natural features of our great state.

Therefore, I, Ann W. Richards, Governor of Texas, do hereby proclaim the week of June 20 through June 24, 1994, as:

CAVE AWARENESS WEEK

in Texas and urge the appropriate recognition thereof.



In official recognition whereof, I hereby affix my signature this

28th day of January, 1994.

Ann W. Richards
Governor of Texas

1994 NATIONAL SPELEOLOGICAL SOCIETY CONVENTION

Hosted by the Cavers of Texas
in cooperation with the
Texas Parks and Wildlife Department

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CONVENTION COMMITTEE

Co-ChairmanJay Jorden
 Co-ChairmanRon Ralph
 SecretaryDonna Anderson
 TreasurerBruce Anderson

CampgroundBlake Harrison
 Cave Trips.....Donna Anderson
 FacilitiesBlake Harrison
 GuidebookWilliam Elliott
 Health and SafetyBob Cowell
 Howdy PartyMike Walsh
 ProgramBill Mixon
 PublicityMichael Anderson
 RegistrationCathy Winfrey
 Special EventsBarbe Barker
 Vendors.....Noble Stidham
 Waltz Across Texas.....George Veni

THE FINE PRINT

Events at this convention are presented by the National Speleological Society, the convention committee, NSS or other groups, or NSS members. Things said or done at the convention may or may not reflect policies or opinions of the National Speleological Society or anybody else.

But you didn't know that.

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From Deep in the Hearts of Texans...

WELCOME!

The Lone Star State—and our hearts—are wide open to our caving friends from across the United States and worldwide. It's been thirty years since the first National Speleological Society convention was held in Texas. Some said it had been too long since the 1964 and 1978 conventions in New Braunfels (and a few wags countered that it hadn't been long enough).

But we all agreed that we'd found an exciting new location: Fort Clark Springs, the 2,700-acre restored Army Cavalry post where cavers can take a step back into history. Strategically located on the edge of the Edwards Plateau where most of Texas's longest and deepest caves have developed, Fort Clark and the adjoining city of Brackettville are less than an hour's drive from Mexico and its caving opportunities. Brackettville is the seat of Kinney Country, which is bordered on the south by the Rio Grande and Mexico.

This time there are dozens of caves, tall tales, and plenty of the best barbecue, chili, steaks, and Tex-Mex ever! For many, it'll be a rare chance to visit Devil's Sinkhole, Texas's fourth deepest cave, located on state park land, and to watch large flights of Mexican freetail bats. A full-scale Alamo, built 120 miles west of the real Texas shrine for a 1959 John Wayne movie, and a replica of early-day San Antonio are just north of Brackettville.

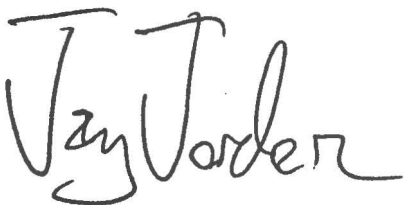
The gateway to West Texas, this quiet ranching and farming community of just over 1,700 people

started as a supply town for the fort, which the U.S. Army established in 1852 to deny the Comanches water from the enormous Las Moras Springs. Projectile points found near the springs date from 8,000 years ago. The fort was later a stop on the Old Spanish Trail from San Antonio to El Paso. Antelope, bison, and wild mustangs then roamed the area and saw fights with Indians as late as 1877. The fort saw service with such generals as Ranald McKenzie, Jonathan Wainwright, and George S. Patton until it closed in 1946.

For the convention, we'd like to say that there's only one rule—there are no rules....unless and until they become necessary. Feel free to retrace the steps of the original Paleoindian settlers. Chase as many armadillos, cook as much chili, and toss as many cow chips as you want to. But, you must check any firearms at the fort gate.

Be sure to read the chapter "Caving in Texas" in the guidebook. Please remember that if any property is posted against trespassing, the owners mean business. Texans have a saying, "Trespassers will be shot. Survivors will be shot again." Also, please leave the bats alone, and don't kill rattlesnakes in the caves.

We hope that this year's convention brings just the right touch of Texas to you. Please remember on this 30th anniversary of the first Texas NSS convention, "Take nothing but pictures, leave nothing but footprints, kill nothing but time."



Jay Jordan
Dallas



Ron Ralph
Waco

MISCELLANY

FOOD

You will have noticed that the streets of Brackettville are not exactly lined with fast-food restaurants. Here are some tips for avoiding starvation.

The prepaid meal plans (breakfasts and three suppers or breakfasts, lunches, and three suppers) will be served outdoors within the walls of the old fort, as shown on the convention-site map. (In case of rain, serving will be in nearby shelter.) Breakfast hours are from 6:45 to 8:45 Monday through Friday, lunch from 11:00 to 1:00, and supper from 5:30 to 7:30. Suppers will not be served on Monday or Friday, the days of the Howdy Party and the banquet. Walk-in customers who have not bought the meal plan may purchase individual meals: breakfast is \$5.00, lunch \$6.00, supper \$7.50.

Food, beer, and soft drinks will be sold in the Service Club building during the entire convention. Hours will be:

Friday night until midnight

Saturday 6:30 A.M. through Monday 6:00 P.M., open continuously

Tuesday through Friday, 6:30 A.M. to midnight

Saturday 6:00 A.M. to 2:00 P.M.

Table-service dining will be available during the convention at the Los Moras Inn in Fort Clark Springs. There are a few small cafes in Brackettville, and a gift shop across from the Civic Center will be serving BBQ and cold drinks. There will be a snack-bar in the Civic Center during part of the convention, and there may also be a concession stand with snacks and cold drinks near the swimming pool.

DRIVING AND PARKING

After their visit to convention headquarters in Shafter Hall to register, most convention-goers will not be permitted to drive into Fort Clark Springs, due to limited parking and narrow streets. Vendors, convention workers, handicapped, and those renting accommodations in Fort Clark Springs should inquire at registration about special passes.

Cars will not be permitted to drive on the grass in the "tent camping" area west of the Fort Clark Springs entrance road, except to park along the road that parallels U.S. 90 inside the fence. Cars may drive anywhere in the "car camping" field east of the entrance road. It has a separate entrance from U.S. 90. Please drive carefully and slowly and do not block anyone else's route in or out.

In addition to the campgrounds parking, there is plenty of

parking at the Kinney County Civic Center, where the largest sessions and the vertical events are being held.

MEDICAL

The convention's first-aid station is in the back room of the Fort Clark Springs fire and ambulance station, just off the bottom of the map on the back of this booklet.

The clinic in Brackettville is shown on both the convention-site map and the town map. Its hours are 9-5 Monday to Friday.

The nearest 24-hour medical facilities are in Del Rio or Uvalde, about 35 miles west or east, respectively, of Brackettville on U.S. 90. In Del Rio is the Val Verde Memorial Hospital, 801 North Bedell, phone (210)775-8566. In Uvalde is Uvalde Memorial Hospital, 1025 Garner Field Road, (210)278-6251. The nearest 24-hour pharmacies are also in those towns.

The emergency telephone number in the area is 911.

COMMUNICATION

There is a bank of pay telephones located adjacent to the outdoor vendors' area. The convention telephone number is (210)563-2119, located in convention headquarters in Shafter Hall.

Amateur-radio operators at convention are asked to use 146.50 MHz. A repeater in Del Rio may be available; if so, information will appear in the daily newsletter, or contact Jay Jorden, KA5YVC. Cavers with CB radios are asked to use channel 2 during the convention.

The cavers' number for Texas cave rescue is normally (210)686-0234—call collect and ask for "Cave Rescue" or "John Kreidler." However, the convention telephone number given above will obviously be the most effective way to request caver help in case of cave accidents during the convention itself.

In case of urgent medical emergencies, the telephone number is 911 in Kinney and surrounding counties.

JUNIOR SPELEOLOGICAL SOCIETY

The headquarters of the Junior Speleological Society, with activities for children during the convention, is in the basement of the Salon Building. Use the ground-level entrance in the rear of the building. More information on activities will be available there, at convention headquarters in Shafter Hall, or in the daily newsletter.

SALONS

The NSS salons of cartography, photographic prints, graphic arts (newsletter covers), children's art, and t-shirts and symbolic emblems will be displayed during the convention in the first floor of the Salon Building. These displays will be in place from noon on Monday until noon of Friday. Details on entering the salons were published in the February 1994 *NSS News*. The photographic print and graphic arts salons will have been judged before the convention. Additional submissions to the rest of these salons may be made at the site of the salons on Monday morning or to the following individuals before that: cartography George Dasher, children's art Barbara Belshaw, t-shirts and symbolic emblems Bill Bussey. The exhibits in the Salon Building are open to the general public.

The Cave Ballad Salon tape will be presented on Tuesday afternoon. The photographic slide salon will be presented Thursday evening. The Video and Multi-Projector Slide Program Salons will be presented on Friday morning. See the daily schedules for further information.

Winners will be announced and medals awarded for all the NSS Salons during the slide program Thursday evening.

VENDORS

Indoor vendors, including the consignment-sales room operated by the convention, are located on the ground floor of the Old Commissary Building. Most vendors will open at 9:00 A.M. on Monday and be open from 9:00 to 5:00 until closing at noon on Friday. Vendors may set up from 10:00 A.M. to 5:00 P.M. on Saturday and Sunday. Consignment sales will be open for receiving merchandise from noon to 5:00 on Sunday and from 9:00 to noon on Monday; it will open for sales at 1:00 P.M. Monday. Further information about the operation of consignment sales is available there.

Outdoor vendors will be located in an area behind the Service Club and across the creek from tent camping, as shown on the convention-site map on the back cover.

OTHER STUFF

Campfires, except those provided in designated locations by the convention, are not permitted in the campgrounds. Cooking fires must be off the ground, such as in a grill.

Showers are located in the field behind the Old Commissary Building. This somewhat out-of-the-way location was required to obtain a suitable sanitary drain, so that the showers would not drain into the spring-fed creek.

Genuine **swimming** attire is required in the swimming pool. Cutoffs and the like are acceptable for tubing or playing in the creek.

There is an **ATM machine** at the bank a couple of blocks north of highway 90 from the flashing yellow light. See the site map.

The hours of the **laundromat** shown on the site map are 7:00 A.M. to 9:00 P.M. daily.

Slides and videos may be shown on an informal basis in a small room off the main eating area in the Service Club. This room, which holds only a small audience, may be used to show slides or videos to a few friends or to preview or arrange your convention presentations. Sign-up sheets on the door to the room should be used to reserve a time, in order to avoid accidental conflicts. The room will be available during the hours when the Service Club is open for food and drink.

Loose or noisy **dogs** will be eaten.

RV generators will not be appreciated in the campgrounds. Artificial music should not be allowed to leak beyond your own camp without consent of all within hearing. (Those who do *not* consent should say so. Be nice; eyeballs gouged out should be handed back.)

We are guests at Fort Clark Springs, and some of its residents live close to and indeed amid the convention facilities. Please be courteous visitors. Do not litter or make unnecessary loud noises.

And, finally, a few words about **rattlesnakes** from Gill Ediger: Rattlesnakes live in this area. It is their home. They are an important part of the ecosystem here. You are an outsider—a visitor to their home. It would seem inappropriate to invade their homes and then kill them for whatever reason you might have. Rattlesnakes are not the enemy. Persons who unduly upset the balance of nature are. Should you encounter a rattlesnake during your visit, you are encouraged to give it a wide berth—enjoy it from a distance, take pictures if you please, and leave the area and the snake as you found them. If you think you are being attacked, quickly and carefully run away.

HISTORIC FORT CLARK SPRINGS

**Has it
All!**

- 9 And 18
Hole Golf Courses
- 2 Restaurants
- Recreation Center
- Giant Spring Fed Pool
- Hiking and Biking Trails
- Museum
- RV Park • Motel Rooms
- 5500 Foot Turf Runway

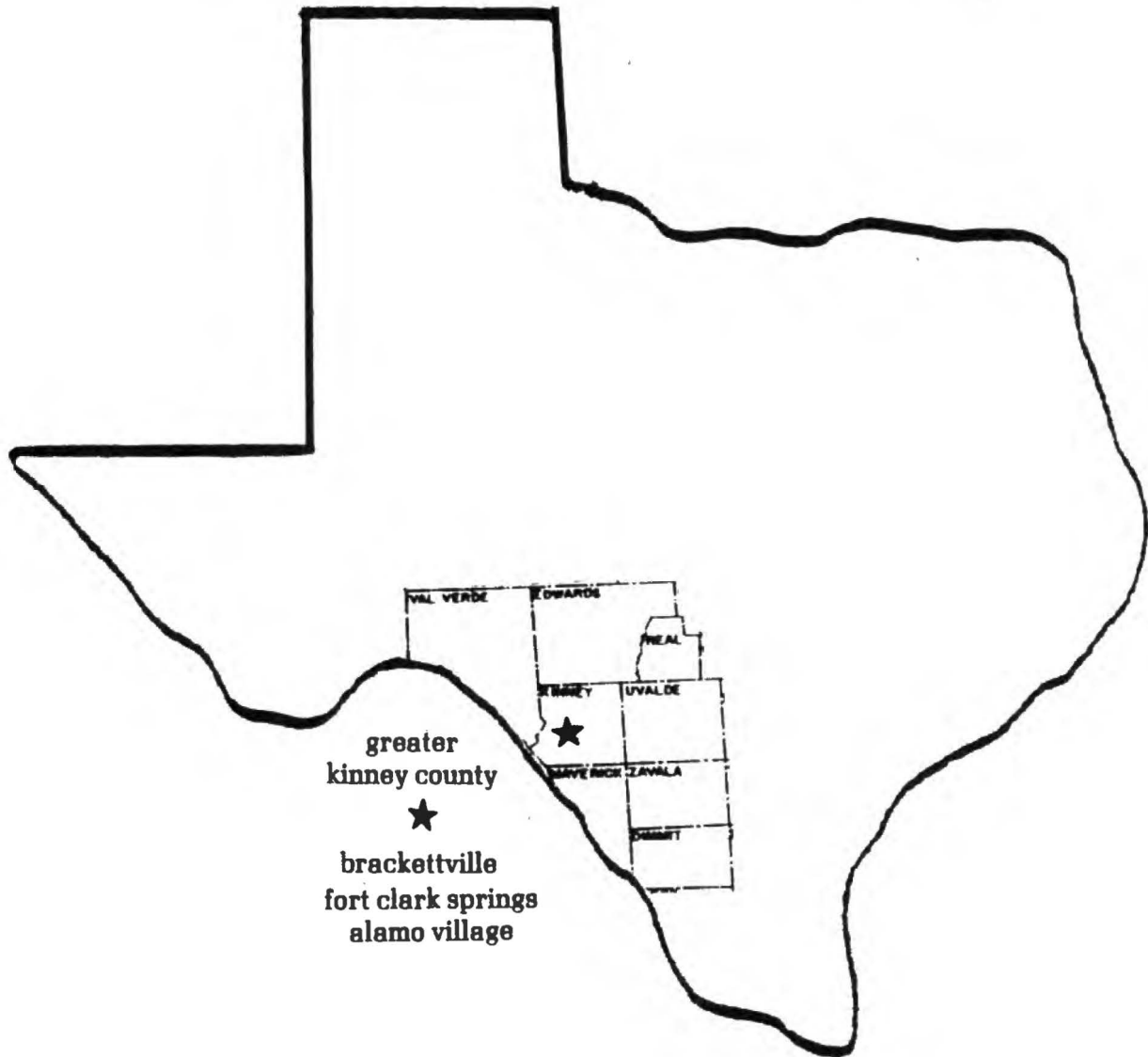


- Abundant Wildlife
- 24 Hour Security
- Historic Setting

**Ft. Clark Springs
Brackettville , Texas**

**Hwy 90 East
210-563-2493**

WELCOME



KINNEY COUNTY CHAMBER OF COMMERCE

Box 386

Brackettville, Texas 78832

210-563-2466

WELCOME
CAVERS TO THE 1994
NSS TEXAS
CONVENTION



U.T. GROTTTO

**UNIVERSITY OF TEXAS GROTTTO, AUSTIN, TEXAS
THE FIRST NSS GROTTTO IN TEXAS**



Waltz Around Texas

All Waltzes will leave Fort Clark Springs between 7:30 and 8:30 A.M. Check your ticket for the departure time of your particular bus. Attendance is primarily by preregistration, although registration and payment may be possible at the convention on a space-available basis; inquire at convention headquarters. All participants must be registered and ride a bus; private vehicles may not follow the buses. (The tours, with the exception of places where special permission has been obtained for Waltz access, may be followed at other times using the road logs in the guidebook, if desired.)

All participants will be provided lunch. The geology trip will include a supper snack and the Green Cave bat flight; if a snack will not tide you over until you get back to Fort Clark Springs for a late supper, bring something additional to munch on. Sun-screen or other protection from the sun is recommended for all trips.

Archaeology/Biology Tour: Buses departing for this trip will be located next to the Shafter Hall convention headquarters. One trip stop may include some easy caving, so be prepared with helmet, lamp, and appropriate clothing (South Texas caves are not very cold).

Geology Tour: This trip will convene in the parking lot on the west side of the Las Moras Inn for a geologic overview, and the buses will depart from in front of the Fort Clark Information Center nearby. For the visit to Kickapoo Cavern bring a helmet, primary source of light (not a pen light or "Mag" light—the passage is large), and appropriate clothing and footwear for the cave (mostly walking on breakdown) and the round-trip hike of about one kilometer from the bus.

Scenic Tour: Buses for this trip will be located at the Shafter Hall convention headquarters. The last stop will be a walk across the international bridge into Ciudad Acuña, Mexico. No special customs papers are needed for this visit to Mexico by U.S. citizens. Foreigners should be sure to have the necessary papers to reenter the United States. Be sure to return to the bus by the time announced by your guide, or you will have to find transportation back to Brackettville at your own expense.

SUNDAY

Green Cave Bat-Flight Viewing

Kickapoo Caverns State Natural Area

Bats usually fly around dusk. See bulletin board for latest information. Allow about one hour to reach the cave from the convention site. Be sure to have your convention badge, indicating you have signed the release form to enter the state natural area.

From Highway 90 in Brackettville, head north at the flashing yellow light on FM 674 approximately 22 miles to the entrance to Kickapoo Caverns State Natural Area. The entrance is the first gate on the left after the "Entering Edwards County" sign. Watch for deer and other animals on the road, especially on the return trip.

Park your vehicle outside the gate on the road right-of-way. Park personnel will be there to direct you and provide security. Parking is limited; please car-pool and offer rides to those without transportation.

From the gate, walk about one mile to the cave. Park personnel and signs will direct you to the viewing area. Special provisions have been made for those with impaired mobility; inquire at the gate.

Be observant. There are snakes and other biting, pricking, or stinging things. Boots, long pants, something to sit on, a flashlight for the return walk, and drinking water are recommended. No other beverages or food in the vicinity of the cave, please. No smoking.

There will be additional opportunities to attend the bat flight on Tuesday and Wednesday evenings. The geology version of the Waltz Around Texas will include the bat flight on Sunday.



ELECTRIC LAMPS, CARBIDE LAMPS, REPAIR PARTS, FLASHLIGHTS, BATTERIES, BULBS



COMPASSES, TAPES, BOOKS, CARBIDE, FIGURE-8'S

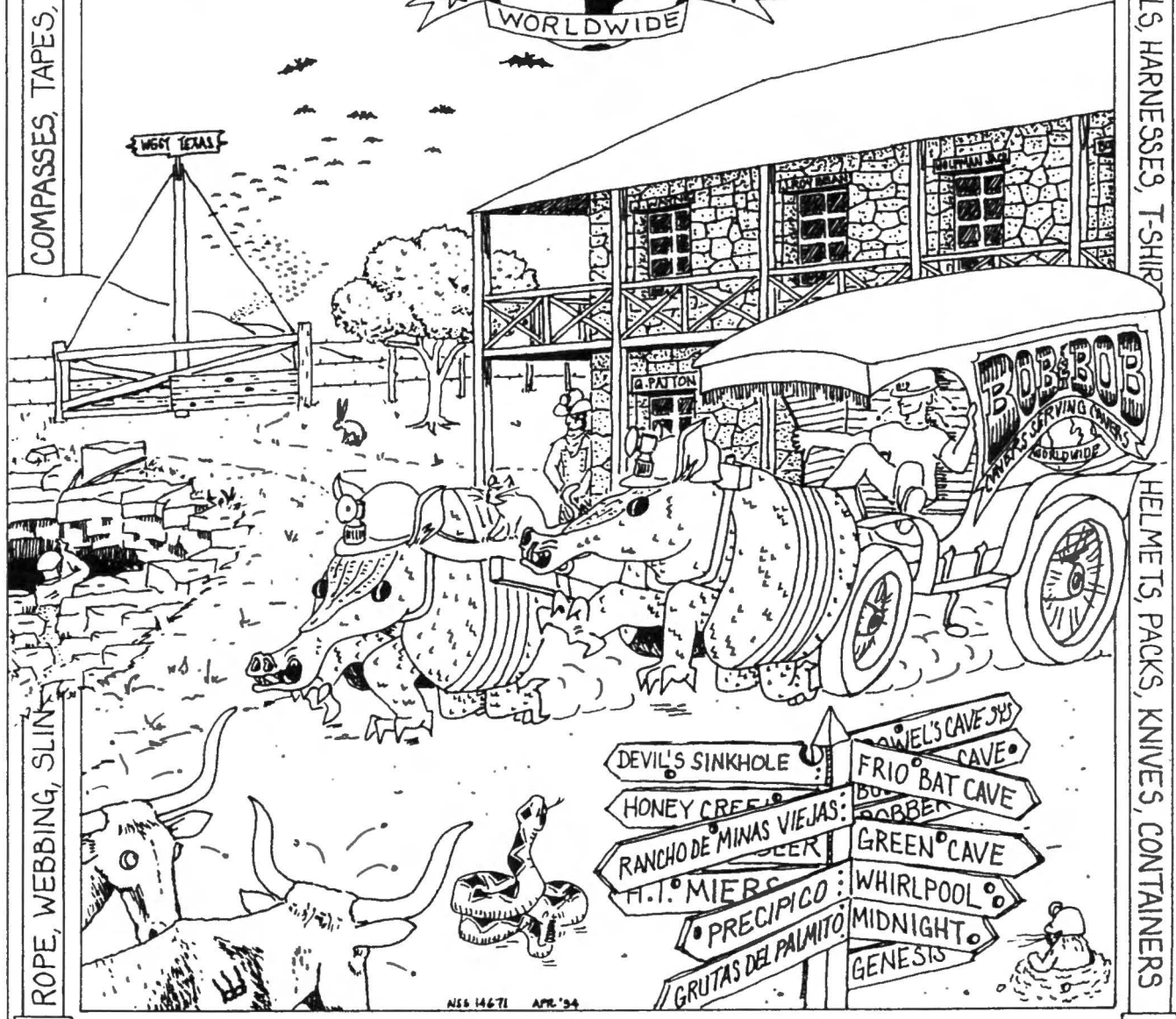
BOB & BOB

P.O. BOX 441
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W. VIRGINIA
24901

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OR TELEPHONE
772-5049
(304)

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HELMETS, PACKS, KNIVES, CONTAINERS



ASCENDERS, RACKS, CARABINERS, CHEST BOXES, CABLE LADDERS, PULLEYS





MONDAY

Opening Ceremony

8:30 A.M.

Empty Saddle Sculpture and Flagpoles

Welcoming remarks and introduction to Fort Clark Springs and the Brackettville area. (Rain location: Old Commissary Building East.)

United States Exploration Session

9:00-12:00, 2:00-5:00

Civic Center East

Pat Kambesis, Chairman

Contributed Papers

- 9:00 Kamanawanaleia Trip to Hawaii: Caves in the Kona and North Mauna Loa Areas. *Dave Bunnell and Doug Medville*. Abstract page 33.
- 9:30 Exploration and Mapping of Caves in the Ailaau Lava Flows, Puna District, Hawaii County, Hawaii. *William R. Halliday and Kevin Allred*. Abstract page 33.
- 10:00 The Exploration of Pit 6083, Hualalai Volcano, Hawaii. *Kevin Allred, David Biunnell, Don Coons, David Doyle, William R. Halliday, and Carol Vesely*. Abstract page 33.
- 10:30 break
- 10:45 Update on Exploration/Survey in Lechuguilla Cave. *Dale Pate*. Abstract page 33.
- 11:15 Recent Explorations in Hidden River Cave, Kentucky. *Chris Groves and James Wells*. Abstract page 34.
- 2:00 Recent Exploration in Carlsbad Cavern: The Chocolate High Discovery. *Steve Reames*. Abstract page 34.
- 2:30 The Powell's Cave System: Texas's Second Longest Cave. *George Veni*. Abstract page 34.
- 3:00 Recent Discoveries in Fisher Ridge Cave System. *Peter Quick*. Abstract page 34.

Symposium on North American and Mesoamerican Cave Archaeology

9:00-12:00

Old Commissary Building West

Janet F. Steele, Chairman

Invited Papers

Members attending this symposium will hear presentations concerning some significant studies of beyond-the-entrance archaeology. The symposium will concentrate on methods and techniques for determining prehistoric use of the dark cave. Papers will address sites in the United States, Mexico, Guatemala, and Belize. Presented in cooperation with the UIS Commission on Archaeological Studies in Caves.

- 9:00 Introductory Remarks: North America.
- 9:10 An Ancient Rocky Mountain Caver. *Cyndi Mosch and Patty Jo Watson*. Abstract page 35.
- 9:30 The Chronology of Prehistoric Exploration in Salts and Mammoth Cave, Kentucky: An Evaluation of the ¹⁴C Determinations. *Mary Kennedy*. Abstract page 35.
- 9:50 Documenting, Interpreting, and Protecting Prehistoric Mud Glyphs in Crumps Cave, Kentucky, United States. *Valerie A. Haskins and Daniel B. Davis*. No abstract received.
- 10:10 Introductory Remarks: Mesoamerica
- 10:20 The Cave of Las Ruinas (Cerro Rabón, Mexico): A Mazatecan Postclassic Funerary and Ritual Site. *Roman Hapka and Fabienne Rouvinez*. Abstract page 35.
- 10:40 The Cueva Cheve Tablets. *Janet F. Steele*. Abstract page 35.
- 11:00 Petroglyph Cave, Belize: An Ancient Maya Ritual Site. *Barbara McLeod and Dorie Reents-Budet*. Abstract page 35.
- 11:20 Regional Variation in Maya Cave Art. *Andrea Stone*. Abstract page 36.
- 11:40 Excavations in Buried Cave Deposits: Implications for Interpretation. *James E. Brady and Ann Scott Schwegman*. Abstract page 36.

Monday continues overleaf

**Opening NSS Board of Governors
Meeting**

9:00-12:00

Old Commissary Building East

This open meeting of the National Speleological Society Board of Governors will include the annual reports of the officers.

**NSS Cave Photography Section Meeting
and Luncheon**

12:00-2:00

Salon Building East

Bring your lunch. The meeting will start at 12:30. All those interested in the activities of the section are invited to attend.

Vertical Contest

9:00-5:00

Civic Center West

Bill Cuddington and the Vertical Section

The popular annual NSS rope-climbing contest, with numerous categories of age and equipment. As this event always draws many climbers, contestants will need to sign up and then be present when their names are called. It will be helpful if climbers can recruit a friend to tension the bottom of the rope, to give the hard-working contest staff a break. The contest will continue on Tuesday. Winners will be announced and prizes handed out at the Contest Awards and Auction event Wednesday evening.

**NSS Paleontology Section
Meeting and Luncheon**

12:00-2:00

Shafter Hall

Bring your lunch. The meeting will start at 12:30. All those interested in the activities of the section are invited to attend.

**Meeting of UIS Commission on
Archaeological Studies in Caves**

12:00-2:00

Old Commissary Building East

Last year the International Union of Speleology created this international commission to heighten effective communication between scientists conducting archaeological research in caves. This will be the commission's first meeting. The commission's objectives are to promote worldwide communication between researchers conducting archaeological studies in caves, to develop working programs on aspects of science and education and protocols for responsible treatment of archaeological cave sites by scientists and cavers, to initiate contacts with cavers and speleological expeditions, and to organize meetings and seminars to report on cave archaeology projects.

The meeting will convene at 12:30. You are welcome to bring a lunch; the meeting and informal discussion may continue into the afternoon, depending on interest. All interested scientists and cavers are welcome and encouraged to attend.

**LEARN Coordinating Committee
Meeting**

9:00-12:00 and 2:00-5:00 (as needed)

Salon Building West

This meeting of the Lechuguilla Exploration and Research Network is open to all interested members. During the first hour of each session, observers may participate in the discussion and raise matters of concern to them. Members are welcome to listen to the Coordinating Committee during the balance of the meeting. (There may be of brief closed session if required.)

Closed Board of Governors Meeting

12:00

Fort Clark Springs Board Room

Closed meetings of the directors and the Board of Governors. The main business will be election of vice-presidents for the coming year. Lunch will be served to the board, the recording secretary, and candidates for office.

Lavender Cavers Luncheon

12:00-2:00

Salon Building West

The Lavender Cavers luncheon is an opportunity for lesbians, gay males, bisexuals, and their friends and supporters to become better acquainted. In addition to networking and planning cave trips, we will be discussing several sexual-orientation issues that relate to the caving community. Although the luncheon is mainly an informal social meeting, we have a few items of business, such as election of officers.

Conservation and Management Session

2:00-5:00

Old Commissary Building West
George Huppert, Chairman
Contributed Papers

- 2:00 Literature Review: Poultry-Waste Pollution, a New Threat in Karst Terranes? (What literature?). *William S. Berryhill, Jr.* Abstract page 36.
- 2:30 Lint in Caves. *Bill Yett and Pat Jablonsky.* Abstract page 36.
- 3:00 Interim Results of the Contemporary Cave Use Study. *John Wilson.* Abstract page 37.
- 3:30 break
- 3:45 Photomonitoring. *Val Hildreth and Jim Werker.* Abstract page 37.
- 4:15 Restoration. *Jerry Trout and Jim Werker.* Abstract page 37.

Chili Cook-Off

Judging at 3:30

Table area at the west end of campground

Organized by Don Metzner

The cook-off will begin Monday morning at the campgrounds with the judging about 3:30, so that the participants and judges won't be too full to enjoy the Howdy Party. This will not be a CASI-sanctioned event. Instead, you cook chili for the fun of it and the chance for your chili to be judged best in one of three categories: chili with meat and no beans, chili with meat and beans, and vegetarian chili (no meat, with or without beans).

Chili cooks are expected to provide their own ingredients, heat source, and cooking utensils. They will be expected to use sanitary cooking methods and to eat a big 'ol spoonful of their chili before doling out a bowlful for the judges. The rest of the chili can be distributed to onlookers or hoarded as the cook pleases, before or after the judging. If interested in cooking or judging, look for chili cook-off sign-up sheets on a bulletin board near registration.

Howdy Party

Monday evening

This traditional social event includes dinner and drink, dancing and good fellowship. It will be held at Alamo Village, about seven miles north of Brackettville on FM 674. Buses will begin running between Fort Clark Springs and Alamo Village at 4:30. (Those attending events that last until 5:00 will have plenty of time to get there before the feed.) Be sure to have your convention badge and your Howdy Party ticket. You are urged to ride the buses if possible. Those with a need to drive themselves may do so, but be aware that deputies will be keeping an eye on drivers leaving the party. (Rain location: Civic Center.)



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TUESDAY

Geology Session, Oral Presentations

9:00–12:00 and 2:00–5:00

Civic Center East

William B. White, Chairman

Contributed Papers

- 9:00 Study of Iron and Manganese Oxide Deposits from Jewel and Jasper Caves, South Dakota, Cave of the Winds, Ocher Cave, Fairy Cave, Premonition Cave, and Porcupine Cave, Colorado, and Two Caves in Arizona. *Fred Luiszer*. Abstract page 37.
- 9:20 Redox Equilibria in the System S-O-H and Its Relation to the Deposition of Elemental Sulfur in Caves. *William B. White*. Abstract page 37.
- 9:40 Preliminary Findings from Experiments on Regeneration of Soil Nitrates in Mammoth Cave, Kentucky. *Rick Olson*. Abstract page 38.
- 10:00 Exploration and Geology of Lava Tubes of the Suchiooc Volcano. *Ramón Espinasa-Pereña*. Abstract page 38.
- 10:20 break
- 10:40 Is This Cave Geologically Significant? *David A. Hubbard, Jr.* Abstract page 38.
- 11:00 Geologic Conditions of the Differentiated Development of Karstification in the Cordillera de Guaniguanico, Western Cuba. *M. Roberto Gutiérrez Domech*. Abstract page 39.
- 11:20 Application of the Standard Tablet Method to a Study of Denudation in Gypsum Karst, Chosa Draw, Southeastern New Mexico. *Raymond G. Nance*. Abstract page 39.
- 11:40 High-Relief Karst in the Laramide-Age Fold-and-Thrust Belt of the Sierra Madre Oriental, Mexico. *Louise D. Hose*. Abstract page 39.
- 2:00 A New Look at Conduit and Diffuse Flow Separation in Karst Aquifers. *George Veni*. Abstract page 40.
- 2:20 General Characterization of the Karstic Landscape of Cuba. *José Luis Gerhartz Muro and Ana Nidia Abraham Alonso*. Abstract page 40.
- 2:40 Flooding of Sinking Creek, Garretts Spring Karst Drainage Basin, Jessamine and Woodford Counties, Kentucky. *James C. Currens and C. Douglas R. Graham*. Abstract page 40.
- 3:00 Application of Geographic Information Systems in the Study of Karst Groundwater Flow at the Drainage Basin Scale. *Kyle Bearden and Chris Groves*. Abstract page 41.
- 3:20 break
- 3:40 The Mysterious Blowing Well of Cibola County, New Mexico. *Jeffery Forbes and Thomas M. McMullan*. Abstract page 41.
- 4:00 Government Regulation of Dye Tracing: The Future. *Albert E. Ogden*. Abstract page 42.
- 4:20 Characterization and Quantification of Nonpoint-Source Pollutant Loads in a Conduit-Flow-Dominated Karst Aquifer Underlying an Intensive-Use Agricultural Region, Kentucky. *James C. Currens*. Abstract page 42.
- 4:40 Flow Energy as Determined from D_{90} and D_{50} in Heterogeneous Cave Sediments. *Daniel W. Ombalski and William B. White*. Abstract page 42.

NCRC Board Meeting

9:00–12:00

Salon Building East

This is a meeting of the Board of Regional Coordinators of the NSS National Cave Rescue Commission. Observers are welcome.

NSS Video Section Meeting and Workshop

9:00–12:00

Old Commissary Building East

Besides the meeting of the Video Section, this event will include informal discussions on making cave-related videos, with an opportunity to view and discuss projected videos.

Tuesday continues overleaf

Cave Photography Workshop

9:00-3:00

Old Commissary Building West

Sponsored by the Cave Photography Section, this workshop will meet for perhaps an hour in a room for orientation and will then car-pool to a local cave for in-cave demonstrations and practice. Those attending should be back at the convention site by mid-afternoon. Be equipped and dressed for easy caving.

NCMS Steering Committee Meeting

9:00-12:00

Fort Clark Springs Board Room

The National Cave Management Symposium Steering Committee consists of representatives of the National Speleological Society and other organizations and agencies. It is responsible for planning the bi-annual cave management symposiums. Observers are welcome at the meeting.

Vertical Contest

9:00-6:00

Civic Center West

This is a continuation of the climbing contest that began on Monday. See page 14.

Rebelay Course

9:00-5:00

Civic Center West

Gary Bush and the Vertical Section

This is an opportunity for those who already have basic rope-work skills to practice techniques of rebelays and redirections. Members of the Vertical Section will be present to give advice and occasional demonstrations on rope courses hung in the same room as the Vertical Contest. You should provide your own vertical gear; a frog system is recommended. There is no cost for this informal event, and registration is not necessary.

Survey Contest

9:00-5:00

Campground

Organized by Hubert Crowell

A mock cave passage in the shape of a figure-8 will be marked off with flagging-tape "walls" somewhere along the creek in the campground. Look for signs. Any group of one or more people may enter. Please bring your own survey gear, as equipment for loan will be limited. A team may select any number of points within the passage for its closed-loop survey. Forms with contest rules and space for recording data will be provided at the site of the contest. Data will be entered into a portable computer, and the winners will be the team with the smaller closure error. The winners will be announced during the Contest Awards and Auction event Wednesday evening.

Shopping Trip to Mexico

9:00-2:30

Organized by Gary Napper

School-bus transportation will be provided, for a fee of about \$6, from the convention site to the International Bridge leading to Ciudad Acuna, Mexico, and return. Taxis and other local transportation are available for those averse to the somewhat long walk across the bridge. This activity is subject to sufficient demand. Further information and registration will be available at convention headquarters in Shafter Hall. If there is sufficient demand, similar trips will occur on Wednesday and Thursday. Trips will occur if there are enough people registered by noon the previous day. Fees will be refunded if trips are canceled.

Speleo Massage Workshop

10:00-12:00

Salon Building West

Organized by Elaine Hackerman

<text>The Speleo Massage workshops began in Texas in 1978 and have covered various topics over the years. This year we will explore self-massage as a way of caring for yourself in caves as well as at the campground and at home. You will have an opportunity to practice this method, which is a head-to-toe do-it-yourself massage. The workshop will also attempt to raise your body-awareness so that injuries may be averted. Come as you are; no special clothing or equipment required. Got a headache? This is the session for you.

NSS Geology and Geography Section**Meeting and Luncheon**

12:00-2:00

Salon Building East

The meeting will begin at 12:30. Bring your lunch. All who are interested in the activities of this section are invited to attend.

Cave Ballad Contest Listening

2:00-4:00

Salon Building East

Organized by Duke McMullan

The tape of the entries in this year's NSS Cave Ballad Contest will be played and discussed.

American Spelean History Association**Meeting and Luncheon**

12:00-2:00

Salon Building West

The meeting of the ASHA, an NSS Section, will start at 12:30. Bring your lunch. All interested in the activities of this section are invited to attend.

Special Evening Tour of Caverns of Sonora

4:30 till late

Organized by George Veni

On Tuesday afternoon beginning at 4:30, buses will depart from in front of the Civic Center for Caverns of Sonora (see your ticket for exact departure time). The drive to the cave will take 2.5 hours. Upon arrival you'll be served a Texas feast prepared by the World Cowboy Outdoor Cooking Competition champion Wayne Sawyer. The 2-hour cave tour will include all developed sections. Bring lots of film for your camera and extra batteries for your flash. Due to the long driving distance, you will return to Fort Clark Springs between midnight and 1:00 A.M. The buses are air-conditioned and comfortable, so you should be able to sleep on the drive back. The cost of the trip is \$30, including transportation, supper, and the cave tour. Tickets are non-refundable. The number of buses going to Sonora will depend on the number of people who have registered by 3:00 P.M. on Monday. Registration after 3:00 P.M. will be on a space-available basis. Be sure to register early (with convention registration in Shafter Hall) to get a seat.

Caverns of Sonora is extremely beautiful but delicate. The following measures are necessary to protect the cave. Please do not use helmets, carbide lights, video recorders, tripod-mounted cameras, or hand-held flashlights. You may use hand-held cameras and flashes, and headlamps held to your head with elastic straps if you want to supplement the regular tour lighting. Please respect and obey the guides who have worked hard to give you the best tour possible.

(Convention-goers who do not attend this special trip are of course welcome to visit this show cave on its regular tours at other times. Special photo tours may be arranged.)

**NSS Rescue Section
Meeting and Luncheon**

12:00-2:00

Shafter Hall

The meeting of the Rescue Section will begin at 12:30. Bring your lunch. All who are interested in the activities of this section are invited to attend.

Speleo Olympics

12:00-3:00

Campground

Organized by Dave McClung

This favorite event will be held somewhere along the creek in the campground. Look for signs. Contestants will race through an obstacle course, and winners will be announced in several age groups. All contestants must bring and wear helmets. The event, which will be assisted by the Junior Speleological Society, will continue on Wednesday afternoon. Winners will be announced and prizes given at the Contest Awards and Auction event Wednesday evening.

Congress of Grottos

2:00-5:00

Old Commissary Building East

This annual meeting of representatives of NSS Internal Organizations provides an opportunity for the membership to discuss and vote on matters concerning caving and the NSS. The Board of Governors considers the results of the Congress at its meeting on Friday. The Congress of Grottos agenda will have been published in advance.

Tuesday continues overleaf

Great Debate

7:00-8:00

Amphitheater

Rane Curl, Moderator

This year's Great Debate, brought to you by the Congress of Grottos, will be on the topic, "Resolved: It is in the interest of the NSS to encourage responsible caving-for-a-fee enterprises." Debating in favor will be Dwight Deal; opposed will be Emily Davis Mobley. This will be a formal debate, with arguments and rebuttals. The actual debate should take an hour. Those stimulated by the debate often remain awhile for informal discussions. (Rain location: Old Commissary Building East.)

Cave Ballad Sing-Along

8:30 P.M. till it's over

Old Fort campfire area

Organized by Donna Anderson

When the sun has set on the convention, you will begin to hear from your campsite the faint strum of a guitar. As you follow the sound, you may also hear the rattle of a tambourine and voices raised in harmony. By the time you get to the Old Fort campfire, you will recognize some of your favorite old cave ballads—stories of daring deeds, stories to set you laughing, stories of cave conservation, and of course lots of stories about bat shit. Bring your guitar, banjo, fiddle, or kazoo. All are welcome to join in the informal sing-along. If you have a new cave song you have written, we would love to hear it. If you don't want to sing it by yourself, bring the words and we'll give it a try. We will start at 8:30 and continue until all voices give out. Cave-related songs only, please. (Rain location: Old Commissary Building East.)

Green Cave Bat-Flight Viewing*Dusk*

A repetition of the opportunity to view an impressive bat-flight that was offered Sunday; see page 11. This will also be repeated Wednesday evening.

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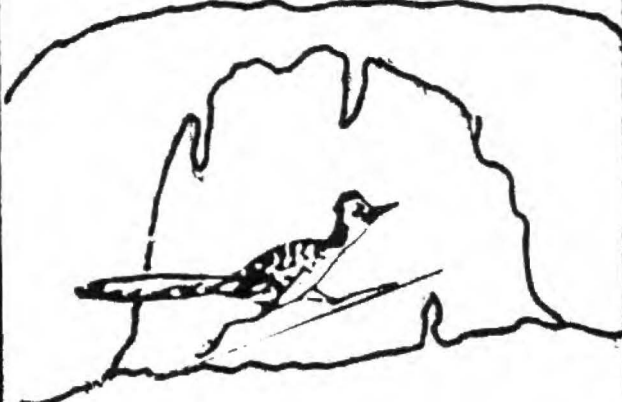
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WEDNESDAY

International Exploration Session

9:00–12:00 and 2:00–5:00

Civic Center East

Carol Vesely, Chairman

Contributed Papers

- 9:00 Reconnaissance Exploration in the Sierra Mixteca Alta, Oaxaca, Mexico. *Louise D. Hose and James A. Pizarowicz*. Abstract page 45.
- 9:30 The Exploration of Kalmanshellir, Iceland, 1993. *Jay R. Reich, Jr., and John H. Rosenfeld*. Abstract page 45.
- 10:00 Hokeb Ha, Belize: Exploration and Research with the Jason Foundation Expedition V. *Tom Miller*. Abstract page 46.
- 10:30 The Purificación Karst in 1994. *Peter Sprouse*. Abstract page 46.
- 11:00 The Cave of the Rio San Ramon, Huehuetenango, Guatemala, March-April, 1992. *Steve Knutson*. Abstract page 46.
- 11:30 The Granite Karst of Atherton Tablelands, Queensland, Australia. *Larry Flemming, Carl Snyder, and Emily Davis Mobley*. Abstract page 46.
- 2:00 Cueva del Mano, Exploration of the Resurgence of Cueva Cheve, Oaxaca, Mexico. *Carol Vesely*. Abstract page 46.
- 2:30 The Semuc Champey, Alta Verapaz, Guatemala—A River Cave Paradise. *Steve Knutson*. Abstract page 47.
- 3:00 Mixlancingo, the Place of Clouds. *Ramón Espinasa-Pereña*. Abstract page 47.
- 3:30 Caving in Guizhou Province, People's Republic of China. *Mike Newsome*. Abstract page 47.
- 4:00 The Cave of the Rio Canlish, Alta Verapaz, Guatemala, April 1994. *Steve Knutson*. Abstract page 47.
- 4:30 Yerba Buena, Chiapas, Mexico. *Don Coons*. Abstract page 47.

NSS Vertical Section Meeting and Discussion

9:00–12:00

Civic Center West

The Vertical Section meeting will include discussions of what is happening vertically within the NSS. It is hard to predict what innovative and thought-provoking vertical activities may come to light during the annual meeting. *On Rope II* and its current progress will be discussed. Election of officers will conclude the meeting. All cavers interested in ropework are welcome.

Shopping Trip to Mexico

9:00–2:30

A repetition of the Tuesday trip. See page 18.

NSS Conservation and Management Section Meeting and Luncheon

12:00–2:00

Salon Building East

The meeting of the section will begin at 12:30. Bring your lunch. All interested in the activities of this NSS section are welcome to attend.

NSS Communications and Electronics Section Meeting and Luncheon

12:00–2:00

Salon Building West

The NSS Communications and Electronics Section seeks to advance cave radio and other mapping aids, rescue communications, lights, instrumentation, and caving applications of amateur radio. Bring your projects and ideas to show and tell, and bring your lunch. There will be a short business meeting at 12:30.

**NSS Speleophilatelic Section
Meeting and Luncheon**
12:00-2:00
Shafter Hall

The meeting of this NSS section will begin at 12:30. Bring your lunch. All interested in cave-related postage stamps are invited to attend.

Speleo Olympics
12:00-3:00
Campground

This is a continuation of the Speleo Olympics begun on Tuesday afternoon. See page 19.

Biology and Paleontology Session, Posters
2:00-5:00
Old Commissary Building Middle
William Elliott, Chairman

No biology and paleontology posters have been scheduled, but the chairman has asked that papers be posted on an informal basis. Stop by and see what shows up. Poster authors are requested to be at or near their papers during most of the afternoon to answer questions and discuss their work with interested people. If their posters are suitable for unattended display, they are requested to put them up in the morning so that those who cannot come by in the afternoon will get a chance to see them.

**Beginners'
Vertical Techniques Workshop**
2:00-6:00
Civic Center West
David McClurg, Workshop Coordinator

All novice vertical cavers 15 years old or older may register for this workshop, which is sponsored by the Vertical Section. The only requirement is a sewn seat harness. The Vertical Section provides all other gear and ropes.

The workshop begins with a short lecture and demonstration covering the following topics: Rappel racks, figure-eights, and rappel bobbins; climbing with Gibbs, Mitchell, and frog systems, or cable ladders; basic caving knots. After the demonstrations, there will be several hours of individual practice of the various skills. Each subject is taught at two or three ropes with two instructors, and students get a chance at each station.

The workshop is limited to 36 students, and is usually sold out by preregistration. Inquire at registration if spots are still

available for the \$15 workshop fee, which includes a printed handout, some lengths of sling material, and wear and tear on the section's equipment. (Sorry, our equipment does not fit cavers under 15 year old.)

**NSS Cave Management Book
Authors' Meeting**
3:30-5:00
Fort Clark Springs Board Room
Organized by Wayne Marshall

This is a working meeting for authors contributing material to the forthcoming NSS book on cave conservation and management. Observers are welcome.

**Closed Meeting of the
NSS Awards Committee**
5:30-6:30
Shafter Hall

A meeting for members of the Awards Committee to discuss policy and other matters arising. Bring your supper.

Contest Awards and Auction
7:00 P.M. till it's over
Old Commissary Building East

Winners will be announced and prizes awarded for the Climbing Contest, the Speleo Olympics, and the Survey Contest. Then there will be the annual NSS auction of donated cave-related items, with all proceeds going to the NSS. Donations may be made through 5:00 Wednesday by taking items to the NSS Bookstore in the lower level of the Old Commissary Building. Kelly "Deacon" Deem is auctioneer.

Green Cave Bat-Flight Viewing
Dusk

This will be the last opportunity to go to Green Cave and watch this bat flight. See page 11.

Pool Area Party and Dance
9:00 P.M. till it's over
Near the swimming pool

"Borderline" band will play. There may be a request for one or two dollars donation to pay for the band.



THURSDAY

Symposium on Biodiversity and Conservation of Cave Faunas

8:30-12:00

Old Commissary Building East

William R. Elliott, Chairman

Invited Papers

- 8:30 Biodiversity and Conservation of North American Cave Faunas: An Overview. *William R. Elliott*. Abstract page 48.
- 9:00 Centers of Biodiversity in Caves. *David C. Culver*. Abstract page 48.
- 9:30 Biodiversity of Subterranean Amphipod Crustaceans: Global Perspective and Strategies for Protection. *John R. Holsinger*. Abstract page 48.
- 10:00 break
- 10:15 Caves and Bats. *Jacqueline J. Belwood*. Abstract page 49.
- 10:45 The Impact of Urbanization on Endemic Cave Fauna in Travis and Williamson Counties, Texas. *James R. Reddell and William R. Elliott*. Abstract page 49.
- 11:15 Biodiversity in Caves: Imperiled or Not? *H.H. Hobbs III*. Abstract page 49.
- 11:45 Panel Discussion. *All speakers*.

Blood Donation Drive

9:00-3:00

Organized by Bill Mobley

This opportunity to give blood through the South Texas Blood Bank will take place at a location to be announced in the daily convention newsletter. At last year's convention, there were seventy donors and twenty volunteers to help out. This year Bill hopes to see a substantial increase. Free T-shirts will be given to donors and other volunteers. Contact Bill Mobley or check for information at convention headquarters to sign up.

Equipment and Techniques Session

8:45-12:00

Old Commissary Building West

John Ganter and Bill Storage, Chairmen

Contributed Papers

- 8:45 Coupling Mineralogical Database Information with Advanced Three-Dimensional Cave Surveying. *John Rowlan*. Abstract page 50.
- 9:15 A 3D Symbol Set for Stage-4 Cave Maps. *Fred L. Wefer*. Abstract page 50.
- 9:45 The OTR Compass Course. *George Dasher*. Abstract page 50.
- 10:15 break
- 10:30 A Lighter, Safer Mitchell System. *Cindy Heazlit*. Abstract page 51.
- 11:00 Cave Rescue Organization, Accidents, and Incidents in Cuban Caves. *M. Roberto Gutiérrez Domech*. Abstract page 51.
- 11:30 Locating the Cave Entrance. *George Dasher*. Abstract page 51.

NSF Meeting

9:00-11:00

Fort Clark Springs Board Room

Among its activities, the National Speleological Foundation manages the investment of many of the NSS's funds. This meeting of the foundation board is open to interested observers.

Shopping Trip to Mexico

9:00-2:30

A repetition of the event on the two preceding days. See page 18.

**NSS Human Sciences Section
Meeting and Luncheon**

12:00–2:00
Shafter Hall

The section meeting of the Human Sciences Section will begin at 12:30. Bring your lunch. All interested in the activities of this section are invited to attend.

**NSS Digging Section
Meeting and Luncheon**

12:00–2:00
Salon Building West

The section meeting will begin at 12:30. Bring your lunch. All interested in the activities of this section are invited to attend.

Women in Caving—A Social Luncheon

12:00–2:00
Salon Building East

Variations on the theme of how women are involved in caving will be discussed. Some topics include trip differences, observations, leadership roles. This meeting is not intended as a “male bashing” or complaints opportunity. This luncheon has been fun and informative in the past. It is not limited to female participation—just ask some of the men who have attended in years past.

Convention Planning Workshop

2:00–4:00
Salon Building East
Kelly Deem, Convention Planning Committee

This informal discussion is an opportunity for workers at past, present, and future NSS conventions to compare notes and for members of groups contemplating offering to host conventions to ask questions and get advice.

Social Sciences Session

2:00–5:15
Old Commissary Building West
John Wilson, Chairman
Contributed Papers

- 2:00 The Importance of Caves in Non-Karstic Regions of Guatemala. *George Veni and James E. Brady*. Abstract page 52.
- 2:30 The Wind Cave Feud. *Nancy E. Holler*. Abstract page 52.
- 3:00 Historical Study and Perspective View of Tourist Caving in Cuba. *Ana Nidia Abraham Alonso and José Luis Gerhartz Muro*. Abstract page 52.
- 3:30 break
- 3:45 The Marginella Burial Cave Project: A Preliminary Report. *David A. Hubbard, Jr., and Michael B. Barber*. Abstract page 52.
- 4:15 History of the Exploration of Sistema Huautla. *Bill Steele*. Abstract page 52.
- 4:45 A History of Woodlee Cave and Dry Cave, Grundy County, Tennessee. *Joseph C. Douglas*. Abstract page 53.

Geology Session, Posters

2:00–5:00
Old Commissary Building Middle
William B. White, Chairman
Contributed Papers

Authors are expected to be at or near their posters during most of the afternoon to answer questions and discuss their work with those interested. In cases where the papers lend themselves to unattended display, authors are urged to mount their posters in the morning so that people who cannot come by in the afternoon can see them. In addition to the scheduled papers, some additional posters are expected.

- Geology of the Cuetzalan Cave System, Puebla, Mexico. *Ramón Espinasa-Pereña*. Abstract page 43.
- How Do Temperature, Humidity, and Carbon Dioxide Affect Epsomite Crystal Growth in a Cave? *Rose A. Galbraith*. Abstract page 43.
- Role of Groundwater in the Development of Pseudokarst Terrain in the Pikes Peak Granite, Colorado. *Louise D. Hose*. Abstract page 44.
- Phosphate Minerals in Yarimburgaz Cave. *Jill P. McMahon*. Abstract page 44.
- Hydrated Uranyl Vanadate Mineral from Spider Cave, Carlsbad Caverns National Park, New Mexico. *Victor J. Polyak and Cyndi J. Mosch*. Abstract page 44.

Intermediate Vertical Workshop

2:00-6:00

Civic Center West

David McClurg, Workshop Coordinator

To qualify for the Intermediate Workshop, you must be an experienced vertical caver with at least one year's experience in basic rappelling and prusiking. You must have your own vertical system for ascending and descending and know how to use it. At a minimum, you need a sewn seat harness, a rappel rack, prusik gear, and a safety Jumar or similar ascender with a sling or etrier. Your system should fit you well and show evidence of previous use.

The workshop will include personal instruction on changing from rappel to prusik and vice versa, crossing knots on rappel or prusik, simple self-rescue in case of a failed ascender or sling, and rappelling with fifty pounds of rope weight below you. Each station will have two or three ropes, two instructors, and four students at a time.

The workshop is limited to 24 students, and will probably be filled by preregistration. Inquire at registration if spots are still available for the \$15 workshop fee, which covers a printed handout and wear and tear on the sponsoring Vertical Section's ropes and other equipment. Students must be over 18 years old.

Histoplasmosis Roundtable Discussion

4:00-5:00

Salon Building West

Organized by John Pint

Histoplasmosis is proving to be a serious problem for those exploring caves in northwestern Mexico. Those with experience with the disease, questions about it, or knowledge on the subject are invited to gather for an informal discussion, which will include the question of whether it would be worthwhile to form an international study group on the subject.

NSS Salons Presentation

6:30-8:30 or 9:00-11:00

Civic Center East

This evening presentation will include announcement of the winners in the various NSS salons, extracts from entries in the Video and Multi-Projector Slide Program Salons, and presentation of the Slide Salon. Because of limited facilities, it is necessary to give this popular Thursday evening presentation in two sessions, limited to two hours in duration. Entries in the Video and Multi-Projector Slide Program Salons will be shown in full Friday morning.

Everyone entitled to attend this presentation should have received a "generic" salon ticket when he registered. Those who have exchanged it at registration for a ticket to a specific one of the sessions, either 6:30 to 8:30 or 9:00 to 11:00, will be guaranteed seats at that session if they arrive and present their specific tickets by the scheduled starting time. People with other tickets will be admitted for a few minutes after the scheduled time as seats permit, but you are urged to exchange your generic ticket to assure your seat. No one will be admitted after the presentation has begun.

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AND FOOD.***



FRIDAY

Biology and Paleontology Session

8:15–12:00 and 2:00–5:00

Old Commissary Building West

William Elliott, Chairman

(Paleontology Introductions by Rickard Toomey)
Contributed Papers

- 8:15 Evolution and Dispersal in Texas Salamanders of the Genus *Eurycea*. *Andy G. Grubbs and Paul Chippendale*. Abstract page 53.
- 8:45 A New Species of the Subterranean Amphipod Genus *Paramexiweckelia* (Hadziidae) from Val Verde County, Texas, with Comments on Its Biogeographic and Phylogenetic Relationships. *John R. Holsinger*. Abstract page 53.
- 9:15 Community Ecology of Three Central Texas Caves. *William R. Elliott*. Abstract page 54.
- 9:45 break
- 10:00 Effects of Septic System Outfall on Macroinvertebrate Populations and Their Food Resources. *Kevin S. Simon and Arthur L. Buikema, Jr.* Abstract page 54.
- 10:30 Long-Term Ecological Monitoring of Karst Resources at Mammoth Cave National Park, Kentucky. *Rick Olson*. Abstract page 54.
- 11:00 Evolution of the Amphipod *Grammarus minus* in Caves: An Analysis of Time. *Daniel W. Fong*. Abstract page 55.
- 11:30 A Preliminary Study of the Invertebrate Cave Fauna of China. *David A. Hubbard, Jr., John R. Holsinger, and Jun Zhang*. Abstract page 55.
- 2:00 Cave Vertebrate Paleontology in Texas. *Rickard S. Toomey III*. Abstract page 55.
- 2:30 Those Damn Bones Are in the Way. *Pat Jablonsky*. Abstract page 55.
- 3:00 Late Quaternary Size, Range and Behavior Changes in Central Texas Bats. *Rickard S. Toomey III*. Abstract page 56.
- 3:30 break
- 3:45 The Blue Lake Rhinoceros: A Caver's Perspective. *Cato Holler, Jr.* Abstract page 56.
- 4:15 Deep Cave Recovery Techniques for Paleontological Specimens. *Patricia L. Jablonsky*. Abstract page 56.

Devil's Sinkhole Film

9:00–10:00

Civic Center East

A movie was made at the Devil's Sinkhole in the late 1940s. Following introductory remarks on the making of the film by Steven Foster, son of the photographer, a video-tape of the film will be presented.

NSS Board of Governors Meeting

9:00–12:00, 2:00–5:00 (as needed)

Old Commissary Building East

This is a continuation of the convention meeting of the BOG that began Monday morning. The meeting is open to anyone who wishes to attend. (If matters arise that require a closed meeting, it will be held during lunch at a location to be announced.)

Video and Multi-Projector Slide Program

Salons

10:00–12:00

Civic Center East

The entries in the NSS Video and Multi-Projector Slide Program Salons will be presented at this time. (Only a sampling will have been presented at the salon event Thursday evening.) There may be other video or multi-media presentations added to this program; they will be announced in the daily newsletter.

Cartographic Salon Critique Session

10:00–12:00

Salon Building

Judges will be present at the Cartographic Salon on the first floor of the Salon Building to discuss the entries with interested observers. This will be a good opportunity to get valuable tips for improving your own cartographic skills.

Friday continues overleaf

**NSS Biology Section
Meeting and Luncheon**
12:00-2:00
Salon Building East

The meeting of the Biology Section will begin at 12:30. Bring your lunch. All who are interested in the activities of this section are invited to attend.

**NSS Survey and Cartography Section
Meeting and Luncheon**
12:00-2:00
Salon Building West

The meeting of the Survey and Cartography Section will begin at 12:30. Bring your lunch. All who are interested in the activities of this section are welcome.

Newsletters Editors' Workshop
2:00-4:00
Salon Building East
Organized by David McClurg

This is an informal session where participants will be encouraged to share their experiences and exchange ideas. Some of the topics to be covered are: How to get people to write for your newsletter. How to use desktop publishing to compose caving newsletters. How to edit material for a correct and consistent style. Copyrights, indexing, and other arcana.

Banquet and Awards Ceremony
6:30 P.M. till it's over
Pool Area and Amphitheater

The closing banquet will be held under the trees near the swimming pool, after which concluding remarks and the National Speleological Society Awards for 1994 will be presented in the nearby amphitheater. Be sure to wear your convention badge to attend the banquet. (In case of rain, these events will be held in the Civic Center.)



The Brackett News.

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Published Each Thursday

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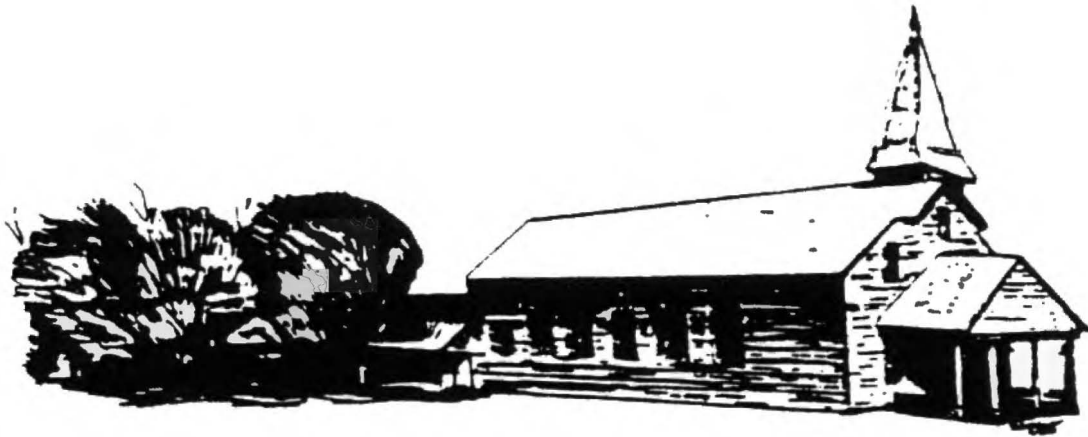
9:45 a.m.
11:00 a.m.
7:00 p.m.

Sunday School
Worship Service
Worship Service

WEDNESDAY

8:00 a.m.
7:00 p.m.

Men's Prayer Meeting
Prayer Meeting



First Baptist Church

Box 308

Ann & Veltman Streets
Brackettville, Texas 78832
210-563-2245

Rev. Gil Ash, Pastor

ABSTRACTS

UNITED STATES EXPLORATION SESSION

Exploration and Mapping of Caves in the Ailaau Lava Flows, Puna District, Hawaii County, HI

William R. Halliday and Kevin Allred

Exploration and mapping of caves in the Ailaau lava flows of the Puna District of "The Big Island" of Hawaii recently has intensified. Several groups are working in the area, with varying degrees of coordination. The Hawaii Speleological Survey has given these lava flows a high priority at the request of the Hawaii Volcano Observatory of the U.S. Geological Survey. With the project still far from complete, these lava flows now appear to enclose the most extensive group of lava tube caves known in the world. World class caves and systems include Olaa Cave, Lower Uilani Cave, Keala Cave, Kazumura Cave, and the John Martin-Pukalani, Paradise Park, Blair, and Pahoa Systems. Pending further information from Korea and Kenya, Kazumura Cave is believed to be the longest lava tube cave in the world as a result of recent exploration headed by Kevin Allred.

Kamanawanaleia Trip to Hawaii: Caves in the Kona and North Mauna Loa Areas

Dave Bunnell and Doug Medville

The 1994 Kamanawanaleia trip to the island of Hawaii took place on Jan. 14-30. Participants were: Dave Bunnell, Don Coons, Doug and Hazel Medville, Dale Pate, Bill and Laura Storage, Carol Vesely, and Cyndie Walck. In the first eight days of this trip, 5.4 miles of passage were surveyed in 27 lava tubes along the Kona coast and on the north side of Mauna Loa. Tube elevations and temperatures ranged from near-sea level and a sweaty 78 degrees along the Kona coast to 11,000 feet and a chilling 37 degrees on Mauna Loa. While many tubes were completely surveyed, several were not finished and remain for future trips.

Two of the tubes surveyed in the Kona area approach each other at their ends. Both end in breakdown crawls and, if connected, would result in a 2 mile long tube—possibly the longest on that side of the island. Almost a mile was surveyed in another Kona tube, its upflow end left unsurveyed owing to foul conditions (remains of a recently dead goat).

On Mauna Loa, the 1855 lava flow produced nearly two

miles of passage in several tube complexes, now connected via surface surveys. One of these tubes had 230 feet of vertical relief and several leads remain. Several other paleo- and historic flows containing tube complexes were examined and 2,000 to 4,000 feet were surveyed in each flow. Some of these tubes were complex, with a 7-way junction noted in one! A variety of interesting features were observed, including extensive crystal and mineral deposits, two inch thick lavacicles up to two feet long, and extensive floors of red and orange pahoehoe.

The Mauna Loa flows, while extensive both laterally and vertically, are not particularly thick and, as a result, the tubes tend to be broken up by entrance collapses and trenches. As a result, the probability of finding very deep or extensive caves in this area is low, despite the long lines of entrances visible on aerial photos.

The Exploration of Pit 6083, Hualalai Volcano, Hawaii

Kevin Allred, David Bunnell, Don Coons,
David Doyle, William R. Halliday, and Carol Vesely

An unnamed pit on Hualalai Volcano, Hawaii County, Hawaii was found to be the deepest pit in the United States in January 1994. To avoid sharp volcanic rocks and loose rubble, descent was from a static line across the 500-foot mouth of the first element of the pit. Depth of the pit below this static line is 810 feet. Details of the pit and of the descent will be recounted. The pit is in a hostile environment, on private land, and an expeditionary approach acceptable to the land managers will be necessary for return descents.

Update on Exploration/Survey in Lechuguilla Cave

Dale Pate

*Carlsbad Caverns National Park,
Carlsbad, New Mexico 88220*

Exploration and survey work in Lechuguilla Cave has been focused on pushing the northern boundaries of the system. To that end, concerted efforts have been made to push the North Rift, the northern boundaries of the Far East Maze and the north-trending passages in the Western Borehole.

In addition to pushing north, exploration/survey continues in other areas of the cave as well. The Dead Seas/Red Seas area in the Western Borehole has yielded a number of nice rooms and passages. And in April of this year a significant breakthrough was made in two areas near Hard Daze Night Hall, also in the Western Borehole.

Recent Explorations in Hidden River Cave, Kentucky

Chris Groves and James Wells
Central Kentucky Karst Coalition,
Bowling Green, Kentucky

Hidden River Cave, in Hart County, Kentucky, has been known for several centuries. The cave's impressive entrance, refreshing natural breeze, and underground river made it a popular spot among local residents and visitors in the 1800's and early 1900's. Sketchy accounts of exploration during the 1930's suggested that about three miles of passages had been seen by that time. Commercial tours of the cave were offered from 1900 until 1942, when pollution of the underground river made tours of the cave impossible.

Dramatic amelioration of the cave's water quality problems led exploration to continue in 1991, as a cooperative project of the American Cave Conservation Association, the Central Kentucky Karst Coalition, and local NSS grottos. Mapping in the large, easily accessible passages in late 1991 soon racked up one and a half miles. Exploration slowed, however for much of 1992 and 1993 due to high water levels, to which the cave is very sensitive due to its location on the sinkhole plain. Very low water levels in the summer and fall of 1993 led to a surge in trips and several major breakthroughs during that time have pushed the known length of the cave to over five miles. A large, fine river trunk called Fractal River has over seventy going leads, including the main passage itself. This may well turn out to be a major cave for the Central Kentucky Karst.

Recent Exploration in Carlsbad Cavern: The Chocolate High Discovery

Steve Reames

Cavers have been exploring and surveying in Carlsbad Cavern, New Mexico, for over twenty years. In 1990 a group of climbers from Colorado started a promising climb in the New Mexico Room. In several trips, spread over two years, they gained over 400 vertical feet and placed a sequence of six fixed ropes. After exploring several small side passages along the way, they finally broke into a new area of the cave which they named Chocolate High. The Chocolate High area, one of the most remote regions of Carlsbad Cavern, has revealed over two miles of new passage. The area is well decorated and geologically interesting. Most of the new passage is in the Yates Formation, above the Massive Capitan which forms most of Carlsbad. This opens the door for future discoveries and the possibility of connecting to nearby Spider Cave.

The Powell's Cave System: Texas's Second Longest Cave

George Veni
11304 Candle Park, San Antonio, Texas 78249-4421

Jim Bowie died at the battle of the Alamo in 1836 and with him died the secret of a supposed fortune in silver buried near present-day Menard, Texas. Treasure hunters pock-marked the area digging for the precious metal. Near the turn of the 20th century one excavation opened what is now the main entrance into the Powell's Cave System, a group of 3 to 4 caves of which the longest is the Powell's segment. The artificial entrance leads into an extensive dry upper level maze, which leads to a lower level stream. Downstream leads to Neel's Cave and upstream to Silver Mine Cave, where a sinkhole and artificial shaft entrance were also dug open in search of Bowie's booty. Farther upstream the passage is suspected to reach a now-filled cave known as the Meteor Hole, a sinkhole whose sudden collapse caused locals to believe it is an impact crater. The Powell's Cave segment was initially surveyed to a length of 22.9 km between the 1960s and early 1980s. The Neel's Cave survey began in 1976 and culminated in 1982 when it was connected to Powell's by using scuba to dive upstream through seven intervening sumps. Silver Mine was surveyed between 1980-83, but repeated attempts have not yet established a route through the breakdown that separates it from Powell's. Significant errors in the 1960s survey prompted a resurvey of the Powell's section in 1989. The resurvey project is one of the more popular in Texas with an average of 47 cavers per trip during its 5-year history. New passages are still discovered, and the resurvey is expected to surpass the cave system's old length within a year.

Recent Discoveries in Fisher Ridge Cave System

Peter Quick

The Fisher Ridge Cave System, in Hart, County, Kentucky was discovered in 1981. The first few years of exploration unfolded miles and miles of new cave. In the late 1980's major breakthroughs became fewer and fewer and mapping slowed down. By 1990 50 miles of passage had been mapped.

In the fall of 1992 passages in the northwestern end of the system were discovered that ultimately led to a breakthrough into a nearby ridge, Northtown Ridge. A very complex and interconnected passage system was discovered. Since the breakthrough in 1992, 18 miles of passage has been mapped in the Northtown Ridge section of the cave. In this new area over 160 leads remain to be pushed, many with good prospects for major discoveries. It is thought likely that Northtown Ridge contains enough passage to increase the length of the Fisher Ridge Cave system to 100 miles within the next 10 years. Arduous exploration continues.

ARCHAEOLOGY SYMPOSIUM

An Ancient Rocky Mountain Caver

Cyndi Mosch and Patty Jo Watson*

**Department of Anthropology, Washington University, St. Louis, Missouri 63130*

Approximately 8000 years ago, a man in his early 40s entered a small cave at an altitude above 3000 meters in the Southern Rocky Mountains. He died there of a cause or causes unknown. His physical remains were found in 1988 by three NSS cavers, who contacted appropriate federal authorities, Native American representatives, and academic and privately-based researchers. In this paper we describe and discuss preliminary results of the Hourglass Cave Study.

The Chronology of Prehistoric Exploration in Salts and Mammoth Cave, Kentucky: An Evaluation of the ¹⁴C

Determinations

Mary Kennedy

Department of Anthropology, Washington University, St. Louis, Missouri 63130

Over the last 30 years a total of 54 radiocarbon determinations have been obtained from Salts and Mammoth Caves in Mammoth Cave National Park, Kentucky. These range from 4120±70 B.P. to 1920±160 B.P. and fall within the Late Archaic and Woodland periods of North American prehistory. I evaluate these 54 determinations, which include 13 new dates on paleofeces obtained in 1993, as they relate to the overall pattern of cave exploration in the two sites. I employ a statistical technique to test whether the dates themselves are stratified in a significant way.

The Cave of Las Ruinas (Cerro Rabón, Oaxaca, Mexico): A Mazatecan Postclassic Funerary and Ritual Site

Roman Hapka and Fabienne Rouvinez

Université de Neuchâtel, Séminaire de Préhistoire, Avenue DuPeyrou 7, CH-2000 Neuchâtel, Switzerland

In 1971 the discovery of a cave beneath the Sun Pyramid at Teotihuacán threw new light on the role of the subterranean in Mesoamerican civilizations. Subsequent discoveries in previously Mayan areas have confirmed the role of caves as sacred sites, with an increasing number being found beneath later major temple structures such as the group found in the Petexbatun region of eastern Guatemala.

A survey has been carried out in a karstic region of the state of Oaxaca, Mexico, situated far from all major ancient

ceremonial and economic centers. We hoped to investigate the importance of the subterranean in Mesoamerican culture, and especially that of the Mazatecs. Recent discoveries made by this and other studies in the Cerro Rabón plateau (Sierra Mazateca) have revealed evidence for previously unknown prominent underground ritual and funerary activities.

Some 52 different caves and rock shelters were surveyed. A brief discussion of the morphological variation encountered and methods of underground archaeological survey will be presented. The cave of Las Ruinas has been chosen for a more detailed examination in this paper. The example of Las Ruinas best illustrates

—a typology for the considerable number and variety of funerary and other structures documented in the cave.

—different aspects of the relationship between human society and the subterranean environment.

The pottery found in the archaeological survey has allowed a relative chronological dating of all 52 studied sites. All belong to the Postclassical Period. The pottery also facilitated an evaluation of external contacts and influences on this region.

The Cueva Cheve Tablets

Janet F. Steele

4830 Winthrop Street, San Antonio, Texas 78249

The Cueva Cheve Tablets were removed from the archaeological site in Chamber 1 of the cave, Cueva Cheve, in the Cuicatec region of Oaxaca, Mexico, in March 1991. The two tablets are boards of the same size (18" length by 7" width by 1/2" thickness) and have a design made of turquoise and jade mosaic inlay. The design relates a battle. Each tablet is broken in two pieces. The tablets likely date from the Cuicatec Late Postclassic. A description of these tablets and the circumstances of their recovery will be reported in this paper.

Petroglyph Cave, Belize: An Ancient Maya Ritual Site

Barbara MacLeod

1705 Ullrich, Autsin, Texas 78756

Dorie Reents-Budet

Duke University Museum of Art, P.O. Box 6845 College Station, Durham, NC 27708

To the ancient Maya, caves were the embodiment of the realm of sleep, dreams, trance, and the afterlife. The more impressive cave systems which were still penetrable by the Classic Maya often show evidence of a ceremonial complex involving human sacrifice, the placing of caches, the ritual destruction of objects, preparation of food offerings, and entry into visionary states.

An extensive investigation, still unpublished, was carried out by the authors in Petroglyph Cave, Belize, in 1978; the project team camped on the floor of the three-hundred-foot entrance sinkhole for five months. This paper will summarize

the findings of an unusual project in a truly remarkable setting. It will be argued that the petroglyphs for which the cave is named are expressions of entoptic art resulting from trance induction.

Regional Variation in Maya Cave Art

Andrea Stone
*Department of Art History,
 University of Wisconsin-Milwaukee,
 P.O. Box 413, Milwaukee, Wisconsin*

The Maya area is well endowed with cave art, one of the rarest art forms known in the world. Over 25 caves with paintings and handprints have been documented in a recent survey by the author and an undetermined additional number contain carvings. This paper outlines regional differences in the corpus. For example, cave painting in the Puuc area of western Yucatan has a relatively coherent style and subject matter, distinct from contemporaneous cave painting in the southern lowlands. Cave painting in southern Belize is stylistically heterogeneous. The paper considers the issue of stylistic variation in Maya cave art from a functional, chronological, and sociological perspective.

Excavations in Buried Cave Deposits: Implications for Interpretation

James E. Brady* and Ann Scott Schwegman
**Dumbarton Oaks, 1703 32nd Street NW,
 Washington, D.C. 20007*

As conduits for transporting water, Maya caves are frequently wet and may be seasonally flooded so they often contain cultural deposits buried under layers of mud which tend to be so plastic that they are difficult to excavate and impossible to screen. In the past, such areas have tended not to be investigated. Ethnohistorical sources suggest that wet or watery places were sought for the performance of rituals. It is important to assess the extent to which archaeology's inability to explore such areas has biased data and interpretations.

The Petexbatun Regional Cave Survey [PRCS] is the largest and most intensive Maya cave investigation ever undertaken. Over the last four years the PRCS has attempted to develop new field techniques for cave archaeology, including several techniques for the exploration of water-logged environments. Over the last two years a method, using chemical deflocculants, has been developed for dissolving cave mud. Field testing of the method in 1993 in areas where the project had conducted complete surface collection recovered large numbers of sherds indicating that sherd density was several orders of magnitude greater than previously reported. In addition, the percentage of Preclassic sherds in the test unit indicate a far more intensive early utilization than suspected. More importantly there is little overlap between the artifact assemblages recovered by the use of deflocculants with that recov-

ered from surface collection which has important ramifications for the reconstruction of cave ritual. In general, this new technique has revealed a greater intensity of utilization in buried areas and has produced an array of small artifacts that reflect a broader range of activities than suggested by surface survey alone.

CONSERVATION AND MANAGEMENT SESSION

Literature Review:

Poultry-Waste Pollution, a New Threat in Karst Terranes? (What Literature?)

William S. Berryhill, Jr.

Several investigators, residents of karst areas, and others have become concerned over the last 3 or 4 years about the potential for water quality problems caused by chicken and turkey farms and by poultry processing facilities. Although a few reports have been published that address general agricultural land-use influences on karst water quality, there are none in the open literature (to my knowledge at present) that deal specifically with the problem of poultry-waste pollution in karst. Yet the threat is very real. I base this opinion on the following facts. The poultry industry is growing. Farms and processors are expanding into areas like the Valley and Ridge counties on both sides of the Virginia-West Virginia border. In some karst areas regulatory control and enforcement are virtually non-existent. Growers like karst because water soaks right into the soil without leaving puddles. Chickens and turkeys are shitting machines, producing significantly more manure on a weight basis than mammalian livestock. They also die, causing a putrefaction problem. A large poultry farm produces *tons* of manure and dead birds, rich in nitrogen, pathogens, and BOD, *per day*. Sediment loading can also cause trouble. Each of the conventional waste management practices (composting, export, burning, feeding, burial, sink-hole dumping, and land application) has drawbacks.

This paper will present a review of the literature on water quality impacts on poultry growing, processing, and waste management. It is necessarily not specific to karst terranes. The literature on agricultural impacts in karst will also be reviewed. And if I can find anything on poultry-waste in karst, it will of course get top billing.

Lint in Caves

Bill Yett and Pat Jablonsky

This presentation will cover the research and investigations explored during the past two years regarding lint and its effects on a cave environment.

Implications and control of lint deposits in show caves has

received scant systematic study. The potentially detrimental effects of uncontrolled lint accumulations in caves include degradation of the appearance of the cave, provision of a food source for opportunistic organisms, and even a medium for dissolving cave surfaces. A number of show caves regularly clean tour trails and cave surfaces with water and a few, use some other methods of cleaning for the abatement of lint. Plausible and useful techniques to control lint are being examined by the authors who are also studying the composition of lint by laboratory methods and the dynamics of lint movement in caves. Conclusions indicate that the most promising strategies to control lint deposits in caves involve careful attention to trail design, custodial and maintenance procedures. The application of some "clean room" technology may also be useful

Interim Results of the Contemporary Cave Use Study

John Wilson

This report presents some preliminary information on the habits of cavers today. Gender differences, aging of the caving population, and changing cave equipment are all topics to be covered. The significance of these trends for cave managers will be considered.

Photomonitoring

Val Hildreth and Jim Werker

During the past year, we have developed a faster, easier photomonitoring system that offers more accuracy and repeatability, streamlines labor and tedium, and reduces cave impact. We will present this efficient, unobtrusive system and compare this new permanent technique to the traditional methods. Topics will include speleothems and areas that should be photographically monitored, recommended supplies/equipment for repeatability, and philosophy/procedures for minimizing cave impact.

Restoration

Jerry Trout and Jim Werker

It is timely to produce a handbook for cave restoration. Our goal is to initiate a forum for gathering techniques and procedures that have been proven in cave environments. We will present information and lead discussion that we hope will become the basis and catalyst for a collection of cave restoration data. Topics will include types of speleothems that can be *repaired*, types of materials that can be *removed*, areas and types of speleothems that can be *cleaned*, and environmentally safe materials and equipment to use. Other issues for discussion include volunteers, documents, safety, logistics, Material Safety Data Sheets, agency agreements, and time involved.

GEOLOGY SESSIONS

Study of Iron and Manganese Oxide Deposits from Jewel and Jasper Caves, South Dakota, Cave of the Winds, Ocher Cave, Fairy Cave, Premonition Cave, and Porcupine Cave, Colorado, and Two Caves in Arizona

Fred Luiszer

Department of Geological Sciences,
University of Colorado, Boulder, Colorado

Samples of Fe- and Mn-oxides from nine Western caves were collected and analyzed by means of XRF, XRD, and SEM. The samples, which typically are cryptocrystalline, earthy, and mostly consist of the minerals hematite, goethite, hollandite, and romanechite, are commonly associated with dogtooth spar. The Fe-oxides typically display evidence indicative of bacterial precipitation by *Gallionella*, *Leptothrix*, and *Siderocapsa*. Samples rich in Fe-oxides contain abnormally high concentrations of arsenic (300 to 15,000 ppm) and lead (200 to 8000 ppm). In contrast, some of the Mn-oxide rich samples contain abnormally high concentrations of thallium (500 to 3600 ppm).

Studies at both the Cave of the Winds and the springs of Manitou indicate that dissolutional formation of cave passages and the deposition of Fe- and Mn-oxides and calcite are related to the mixing of CO₂-rich mineral water and meteoric water. The similarity of the Fe- and Mn-oxides and associated deposits from all nine caves in this study suggests a similar origin.

Redox Equilibria in the System S-O-H and Its Relation to the Deposition of Elemental Sulfur in Caves

William B. White

Department of Geosciences, The Pennsylvania State
University, University Park, PA 16802

Redox equilibria for various reactions in the sulfur-oxygen-hydrogen system were recalculated from the most recent thermodynamic data. These calculations were compiled into a redox potential (pe) – pH diagram. The results include a slightly revised boundary curve between reduced sulfur (H₂S and HS⁻) and oxidized sulfur (SO₄⁻²), the total sulfur activity at which solid sulfur first appears, and expansion of the sulfur field with increasing sulfur activity, and the pe, pH, and sulfur activity under which solid sulfur coexists with crystalline gypsum.

Preliminary Findings from Experiments on Regeneration of Soil Nitrates in Mammoth Cave, Kentucky

Rick Olson

*Division of Science and Resources Management,
Mammoth Cave National Park,
Mammoth Cave, Kentucky 42259*

Historical references to the regeneration of nitrate minerals in cave soils are plentiful and have persisted for centuries. In contemporary literature on the subject, regeneration is largely accepted as a reality. Whereas some supporting analytical data have been presented, a controlled set of experiments have not been carried out, and that is the purpose of this investigation. Soil from three sites in Mammoth Cave has been leached of nitrates, split into 25 gram aliquots, packaged in permeable polyester cloth, and repositioned for regeneration under four different sets of conditions. At six month intervals, a soil sample representing each site and treatment has been retrieved and analyzed for nitrate. The greatest degree of regeneration has occurred in the group placed in contact with bedrock, and this explains why niter miners reportedly shoveled leached soil onto ledges for regeneration.

Exploration and Geology of Lava Tubes of the Suchiooc Volcano

Ramón Espinasa-Pereña

*Instituto de Geografía, UNAM; Ingenieros No. 29,
Col. Escandon, C.P. 11800 Mexico D.F., Mexico*

Beginning in 1992, a complex set of lava tubes has been discovered, explored, and mapped in the lava flows of the Suchiooc, one of many volcanoes in the Chichinautzin monogenetic volcanic field. These explorations have included the longest and the deepest lava tubes mapped in Mexico, together with the discovery of an important archaeological site deep into one of the caves. In total over 10 km of passages have already been mapped.

In recent years several papers have appeared with detailed descriptions of lava tubes in Hawaii (Wood, 1981) and in California (Waters et al., 1990). It is generally accepted that lava tubes form either by crusting of open lava channels or by the chilling of a shell around flow units (pahoehoe toes), and their later coalescence through remelting by continued flow of lava through some of them. This latter evolution has never been explained in detail, but has been inferred from the known process of emplacement of multiple lava flows and the relationships found between lava tubes and adjoining rock.

The longest and most complex lava tubes in Suchiooc occur in a branch flow from the main lava flow. A gradation is noticeable between the upper caves, where a master tube has developed, and the lower, less evolved tubes, where the system shows a tridimensional distributary and anastomosing pattern. The presence also of a large feeder tube cave, with no branches,

higher up, helps us theorize about the evolution of lava tubes in a general way.

The most commonly cited form of lava tube formation, crusting of open lava channels, probably only happens near the vent, as in most of the flow the emplacement will be through pahoehoe toes. These will essentially function as capillaries in an artery system, and will present a very complex, tridimensional distributary pattern. As lava continues to flow through these micro-tubes, they will enlarge through remelting of their walls and start to coalesce. Those micro-tubes located in the hydraulically most efficient position will eventually pirate the flowing lava from the other tubes. Through continued flow along this tube, the walls and especially the floor will be eroded by remelting, creating a canyon shaped passage, while the upper tubes, now mostly inactive, might remain drained, but are most commonly refilled and plugged, during the same eruption, by surges in lava extrusion. This way a master or feeder tube, essentially unbranched, is developed. It is possible that the master tube has more than one, superimposed or stacked levels. These have usually been explained as later flows developing a tube above a preexisting, previously drained lava tube. It is found here that, as the lava inside the master tube erodes its canyon, its surface will start crusting, developing levees, benches or even complete crusts that then separate the tube into upper and lower levels.

This same pattern of a deep, canyon or stacked shaped feeder tube cut deeply into the lava flow, and near surface, complexly anastomosing smaller tubes can be recognized in almost all published descriptions of lava tubes. It is perhaps made clearer in Suchiooc, located at the top of a very steep and long escarpment, so the general gradient is much larger (up to 20% slope) than in shield volcanos, where lava tube studies have concentrated. In spite of these differences, it is felt that these conclusions are applicable to almost all lava tubes.

Is This Cave Geologically Significant?

David A. Hubbard, Jr.

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The term "geologically significant" has different connotations depending on one's perspective. Geologists, cavers, resource managers for federal agencies, and cave geologists unanimously agree that some caves are geologically significant, but they may not agree on others. The Virginia Cave Board evaluates the Commonwealth's caves in eleven categories for archaeological, biological, depth, economic, esthetic, geological, historical, hydrological, paleontological, length, and recreational significance and selects the top ten percent of the caves for its Significant Cave List. It has been argued that virtually all caves are geologically significant by virtue of their existence. By this argument, all caves containing troglodiles or troglodites would be considered biologically significant. A more meaningful set of criteria to distinguish significance is useful. Significance is exhibited by outstanding or classic

features characterizing speleogenesis, geomorphology, stratigraphy, structure, or mineralogy, such as fracture controlled maze pattern, vadose or phreatic solutional features, dome pits, sections of stratigraphic formations or sediments, faults and fault related features, rare or unusual minerals or speleothems or speleogens. Caves that have been mined for minerals or mineral resources such as onyx, saltpetre, etc. should qualify as geologically significant. A goal of this talk is to encourage discussion among geologists of what constitutes geological significance with respect to cave resources.

**Geologic Conditions of the Differentiated
Development of Karstification in the
Cordillera de Guaniguanico,
Western Cuba**

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The Cordillera de Guaniguanico is located in the province of Pinar del Río in western Cuba. This mountain chain is composed of the Alturas del Norte y del Sur, the Sierra de los Organos and the Sierra del Rosario. These mountains are characterized by their complex geologic structure typical of alpine mountains, deformed by neotectonic events. The rocks that make up these mountains are made up of siliciclastic, carbonate and siliciclastic-carbonate sequences from the Jurassic to the early Eocene. The central region, where limestones predominate, is considered to be the traditional capital of the cone and tower karst of Cuba.

The drainage network mainly originates in the Alturas de Pizarras and drains to the area where the carbonate rocks predominate. This drainage combined with the autochthonous waters have developed numerous karstic forms. The largest cave systems of the country are among these landforms. The cave systems of Santo Tomás, Majaguas-Canteras, Fuentes, and Palmarito are located in the Sierra de los Organos. Each of these systems of more than 20 kilometers in length, along with the smaller ones, are composed of several tiered interconnected cave passages. The surface karst is related to the morphology of the existent karren, mogotes, poljes, etc. All this karstic apparatus is originated in the massive or irregularly stratified limestone rocks. These rocks have a low porosity, but are highly fractured. The development of the karst is directly related to the location of the lines of fracture and the bedding planes, as well as to the neotectonic movements and eustatic sea level changes. The cave systems of Los Perdidos, Cañón del Santa Cruz, and Rangel, among others, are located in the Sierra del Rosario. Each of these systems is at least 10 kilometers long, and also shows tiered cave passages, although not as well defined as in the Sierra de los Organos. The relief in Sierra del Rosario is different from Los Organos because of the more massive character of the higher groups and the

predominance of great fluviokarstic valleys. This karst is originated in well stratified limestones that are highly fractured and sometimes interbedded with impermeable rocks. The karst is principally developed along bedding planes and fracture planes, in combination with neotectonic movements and eustatic sea level changes. [Translated from Spanish by Myrna Martinez.]

**Application of the Standard Tablet
Method to a Study of Denudation in
Gypsum Karst, Chosa Draw,
Southeastern New Mexico**

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Most studies of karst terrain development have been conducted in limestone karst. Studies of gypsum karst development and denudation are sparse. Very little research of this type has been conducted in the United States. The standard tablet method is one technique which has been used in the study of limestone denudation rates. A modification of this method is used in this study to analyze denudation rates in gypsum karst in southeastern New Mexico.

Exposed bedrock surfaces in the gypsum karst appear to undergo the most rapid denudation. Exposure to denuding processes such as precipitation and abrasion appear to increase denudation rates. Denudation of buried bedrock surfaces is slower than that of exposed surfaces.

The standard tablet method can be a valuable tool when studying the mechanisms of gypsum cave formation. While this technique does not provide rates which are absolute, it does provide information concerning relative denudation rates, which can lead to a better understanding of the mechanisms of gypsum cave formation.

**High-Relief Karst in the Laramide-Age
Fold-and-Thrust Belt of the
Sierra Madre Oriental, Mexico**

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All of the 1000+m caves in Mexico are developed within the Laramide-age fold-and-thrust belt of the Sierra Madre Oriental. Hydrologic drainage follows axial plane fractures, synclinal troughs, primary and auxiliary fault planes, and the intersections of bedding planes and diastrophic joints. Natural stoping of pervasively fractured limestone that collapses into vadose passages and is removed by dissolution facilitates cavern development.

A New Look at Conduit and Diffuse Flow Separation in Karst Aquifers

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The concept of conduit and diffuse flow in karst aquifers is intuitively apparent to anyone who has stood in a swiftly-flowing cave stream and watched water slowly drip from the ceiling. In recent years, the effectiveness of techniques used to separate conduit from diffuse flow in cave stream or karst spring hydrographs has been questioned; some known conduit systems produce low-variation hydrographs expected of diffuse flow aquifers. However, I've discovered that karst springs predominantly discharge diffuse flow when the hydrograph recession coefficient (a) is less than 0.01, fissure flow when $0.01 < a < 0.1$, and conduit flow when $0.1 < a$. These values were determined by dividing hydrographs into segments of equal slope, calculating a for each slope, and plotting them against the segments' mean discharge. Breaks in the resulting curves occur at each of the above values, which, with supporting geochemical data, demonstrate the validity of their relationships. Thus springs with low-variation hydrographs may discharge from conduits, because their groundwater is predominantly released from diffuse storage. The above relationship proves that karst aquifers are comprised of conduit, fissure, and diffuse flow components, and that while a continuum of conditions exist, hydrologic behavior is governed according to which component dominates the conditions observed. These values now allow for a theoretical basis in hydrograph separation and interpretation, and provide standards for more meaningful comparison of different spring flows.

General Characterization of the Karstic Landscape of Cuba

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The objective of this study is to spread the existing knowledge about karst development in Cuba. In addition the relation with the assimilation, transformation, and nature conservation processes, as well as the spatial differentiation of the morphological and genetic types of the caves are presented.

The Cuban archipelago, with an area of 110,992 km², is composed of the great island of Cuba, the Isla de Pinos (today "Isla de la Juventud"), and another 4,195 islands and cays. This group of islands has had a complex paleogeographic evolution that is characterized by its origin during the formation of the American mediterranean. The setting of this evolution was in the zone of interaction of the Caribbean plate and

the North American plate, which produced a mosaic of igneous, metamorphic and pyroclastic rocks. These rocks have been deeply folded, faulted and dislocated by horizontal movement of the plates mentioned above, typical of the evolution of a continental margin with island arcs. Over this complicated folded basement there are strong carbonate sequences that were deposited primarily during and after the Miocene, also on top of the basement there are some outcrops of almost pure calcite that are sometimes metamorphosed. One of the conditions that promoted the ample spreading and differentiation of the karst landscapes in the Cuban archipelago is the eustatic sea level change that resulted from glaciation during Neogene and Quaternary times. Another of the factors that promoted this spreading was the development of neotectonic movement.

The analysis of all the factors that developed the karstic landscapes serves as a starting point to understand the speleogenic and speleomorphologic characteristics of the country. This analysis is also important in the understanding of the influence of these characteristics in the assimilation processes of nature and their role in the differentiation of the humanized space, arising from an uneven distribution of natural resources. These characteristics have conditioned the development of several kinds and degrees of modification of the karst landscape, posing the need to consider special conservation and protection measures, based on particular legislation. [Translated from Spanish by Myrna Martinez.]

Flooding of Sinking Creek, Garretts Spring Karst Drainage Basin, Jessamine and Woodford Counties, Kentucky

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In February 1989 a major storm crossed much of the eastern interior United States, causing widespread flooding. Sinking Creek, a large karst valley in northern Jessamine County, Kentucky, flooded, damaging several homes and closing a county road for over 2 weeks. The Kentucky Geological Survey began a study of the flood response of the Sinking Creek drainage basin in the fall of 1989. The objectives of the research are to determine the limitations on intake capacity of the Sinking Creek swallets, and estimate the impact of land-use changes in the basin.

Sinking Creek is the larger southeastern branch of the Garretts Spring karst basin. The smaller northwestern branch drains part of east-central Woodford County. Chenault Karst Window lies in the northwestern sub-basin, and Owens Karst Window lies in the southeastern branch between Sinking Creek and Garretts Spring. The total drainage area of the basin is 4,766 acres (19.3 hectares). The confluence of the sub-basins is underground and within 1,500 feet (457 m) of the resurgence at Garretts Spring.

The field phase of the study included ground-water tracing and the installation of stage recorders in Chenault and Owens

Karst Windows and along the main truck of Sinking Creek. Staff gauges were also installed at major tributaries. Discharges were measured at these sites, and rating curves were developed for key stations. Garretts Spring was instrumented and monitored by Dr. Gary Felton, University of Kentucky Department of Agricultural Engineering, who also provided the land-use data for the drainage basin. Other work included development of a simple flow-budget model for the three monitoring stations and Garretts Spring. The potential impact of future land-use changes is currently being investigated using data provided by the U.S. Army Corps of Engineers to model flooding, using the HEC-1 flood hydrograph model.

Data from stage recorders and field observations demonstrate that the stage in Owens Karst Window is controlled by the rate of outflow from Sinking Creek Karst Valley in a complex feed back loop. As the stage in Sinking Creek rises, an overflow conduit to Owens becomes active. The flow from Sinking Creek, combined with quick overland flow from the Owens surface catchment, then exceeds the Owens swallet capacity. This causes an initial rapid rise in the stage in Owens, reducing the head difference with Sinking Creek, which reduces the effective swallet capacity at Sinking Creek. After cresting, the stage in both Owens and Sinking Creek drops at the same gradual rate. The discharge from the overflow conduit eventually ceases, which drastically reduces flow into Owens and causes a precipitous fall in stage in Owens Karst Window. This fall is accompanied by rapid draining of the remaining storage from Sinking Creek. The parallelism of the hydrographs of the impounded Sinking Creek and Owens Karst Window, and water-budget data for the basin, indicate that the outflow from Owens is nearly the same as the outflow from Sinking Creek. Inflow into Sinking Creek has been measured at over 180 cfs (5.1 cms). Free air-surface swallet capacity at Sinking Creek is exceeded at 25.4 cfs (0.7 cms), and the maximum capacity observed is approximately 36 cfs (1.0 cms). The maximum outflow observed at Garretts Spring is 58.6 cfs (1.7 cms), but is estimated to reach 70 cfs (2 cms). The restriction to flow from Sinking Creek is due to the hydraulic efficiency of the conduit between Owens Karst Window and the confluence of the sub-basins because flow from Sinking Creek into Owens Karst Window matches or exceeds the flow out of Owens.

The implications for future flooding in the basin are serious. The cave conduits developed in equilibrium to peak flows from a wooded basin. Current land use, including residential development, has both increased the peakedness of the hydrograph and the total volume of runoff in comparison to a woodland. A project to increase discharge capacity of Sinking Creek would require a huge standby pumping capacity or long drainage tunnels. Alternative solutions include prohibiting further residential development in the flood plain, limiting land-use changes in the basin that increase or quicken runoff, and requiring construction of retention basins, that have the capacity to retain peak flows for days, before new development is permitted.

Application of Geographic Information Systems in the Study of Karst Groundwater Flow at the Drainage Basin Scale

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This research concerns the development of new tools and techniques for groundwater research and resource management in the Central Kentucky Karst. The flow patterns within karst drainage systems are closely related to original patterns of secondary porosity and are therefore site specific. In order to make informed management and planning decisions concerning these regions, detailed hydrogeologic investigations of specific drainage systems are required. The main focus of this project is to develop software tools that can be used to store, analyze, and make available both spatial and attribute data that result from such investigations. Such data may include physical information on caves, dye traces, geology, and topography, as well as cultural information for the surface above a particular flow system, such as landuse and landowner data.

Geographic Information Systems (GIS) computer software may be applied to address this need. GIS programs are capable of storing and manipulating a variety of data types and are ideal for applications such as this which involve highly spatial information.

A GIS database structure was constructed for a "test" karst ground water drainage basin, the Poorhouse Spring drainage basin in northern Warren County. Data necessary for the accurate characterization of this flow system were identified, collected, and entered into the database. This system may be implemented to aid decision making in planning and resource management in the area and the methods used in development of the database can be utilized to develop GIS applications in other karst flow systems. An important focus has been to develop menus within the system to make the information accessible to individuals without extensive training in GIS.

The Mysterious Blowing Well of Cibola County, New Mexico

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We are investigating an unusual blowing well located approximately 50 miles west of Albuquerque, New Mexico. The 6-inch diameter well is 623 feet deep and the depth to water is about 465 feet. The well is remarkable because it alternately inhales and exhales large volumes of air in response to fluctua-

tions in barometric pressure.

Volumetric air flow rates monitored over a 2-day period using a Pitot tube revealed air flows of up to 7000 liters/min (250 cfm), with approximately 6000 m³ (210,000 ft³) of air exhaled during a 24 hour period. This is equivalent to the volume of air within a cube 60 feet on a side. Falling barometric pressure results in exhalation of subsurface air from the well, while rising pressure causes flow reversal and inhalation of outside air.

The impressive breathing well probably intersects a cave developed in the upper San Andres Limestone (Permian). A huge travertine deposit ($\approx 10^9$ metric tons) that precipitated along extinct fissure spring vents lies adjacent to the well, and the ancient springs were likely hydraulically connected with the cave intersected by the well.

At least 4×10^8 m³ of San Andres limestone must have dissolved to produce the travertine deposit. Presumably the cave intersected by the flowing well is of similar or greater volume. This is equivalent to a 10 m \times 10 m cave passage 4000 km long! A videolog survey of the breathing well is planned to determine if the hypothetical cave really exists.

Government Regulation of Dye Tracing: The Future

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Due to an increasing use of tracers in the ground water cleanup business, government regulators have become concerned with the potential of cross contamination of traces and the qualifications of those conducting the work. Many facilities, such as Superfund sites, have a number of responsible parties. Often, neighboring facilities with ground water problems hire different consultants who usually keep their investigative techniques and cleanup strategies held under secrecy. If two facilities were to conduct dye traces during the same time period, the results could cause false positives and potentially create economically disastrous results from unnecessary remedial actions. This is more likely to occur in non-traditional karst aquifers where tracers move slowly such as through thick soil mantle or a dolomitic aquifer. In these hydrologic settings, a tracing agent may reside in the subsurface for months or even years. As a result, some states are requiring registration and approval of a ground water trace before it is conducted. In Tennessee, this is handled under the Underground Injection Well Program. Although this process is good for the environmental business, the question is how will it affect cavers? Will the government stop a caver from conducting a dye trace? Will a caver have to establish his qualifications, take tests, or pay professional registration fees? This could be the future.

Characterization and Quantification of Nonpoint-Source Pollutant Loads in a Conduit-Flow-Dominated Karst Aquifer Underlying an Intensive-Use Agricultural Region, Kentucky

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The Pleasant Grove Spring Basin, in southern Logan County, Kentucky, was selected for study because it is largely free of non-agricultural pollution sources. The drainage basin boundary was mapped and the basin area is approximately 10,082 acres. Reconnaissance water samples were collected at six locations over a 14 month period. Several sites were evaluated for continuous monitoring instrumentation. Pleasant Grove Spring, the principal resurgence for the basin, was instrumented to continuously monitor five water quality parameters, stage, discharge velocity and automatically collect event samples.

Results indicate that although nitrate is the most widespread, and persistent contaminant in the basin, concentrations do not exceed MCLs. Atrazine has been consistently detected in low concentrations and other pesticides occasionally occur. Triazines (including atrazine) have exceeded drinking water MCLs during spring-time flood events. Bacteria counts typically exceed drinking water limits and indicate a health hazard.

Flow Energy as Determined from D_{90} and D_{50} in Heterogeneous Cave Sediments

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Clastic sediments in caves vary widely in lithologic characteristics from clays and fine silts to boulders of considerable size. Although deposition of clastic sediments tends to be chaotic with a stratigraphy that varies greatly over short distances, the overall distribution of sediment sizes is a function of the energy of the moving water that transported them to their site of deposition. The idea that flow strength or competence can be taken from the maximum and average grain size of a deposit is based upon the use of the critical shear stress for a particular bed. In a cave, the slopes and widths of stream channels change over short distances and flow velocities are constantly varying. For this reason the shear stress for a particular bed was calculated independent of bed shape, flow velocity, stream width, and grain density. The critical shear stress, T_{ci} , for a particular grain size (D_i) from a heterogeneous deposit may be calculated by

$$T_{ci} = T_{c50} D_i^{0.35} D_{50}^{-0.65}$$

where D_{50} is the mean grain size and T_{c50} is the shear stress required to move a grain of size D_{50} from the deposit. The

maximum shear stress calculated from this equation has units of force and is converted to energy by multiplying the shear stress by the water volume per unit bed area. The relationship was tested by collecting published data on grain size distributions from caves in West Virginia, Kentucky, Minnesota, and others. There is a linear relation between energy and maximum grain size (D_{90}) of the form

$$E = 0.022 d D_{90} + 0.014, r^2 = 0.89$$

where d is the flow depth. The relationship allows the energy of a cave depositional environment to be determined from measurements on clastic sediments. The energy parameter then can be used to compare paleoflow regimes between caves or within the same cave as the system evolves through time.

Geology of the Cuetzalan Cave System, Puebla, Mexico

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Since 1991, four small SMES (Mexico) – NCC (Great Britain) joint expeditions have been fielded to the Cuetzalan area, in the northern portion of the state of Puebla. Although originally explored in the late 1970's and early 1980's, and described as "one of the finest and most going cave systems in the world," no proper survey was ever published, and interest declined. The four SMES-NCC expeditions have surveyed a total of 75 km of cave passage, 50% being made up of new discoveries, and have succeeded in extending all the main systems previously known.

Together, with the exploration and mapping, a lot of effort has been put into research on the geological factors that control this giant karst drainage basin.

The Cuetzalan cave system and associated caves are developed in a sloping monocline, with all beds dipping north at about 8 degrees, breached by surface drainage to create a high-standing, inclined mesa. Cave development is essentially along the contact between the Taman Limestone and the underlying Cahuwas Conglomerate, and is mostly controlled by fractures and small scale normal faults. The Taman limestone is ~80 m thick, and is transitionally overlain by the Pimienta Shales. The caves that open at higher levels tend to drop rapidly to the Cg-Ls contact level, although some extensive caves have developed on carbonated horizons in the Pimienta Shales that overlie the Taman Formation.

The main Cuetzalan System is made up of 3 separate subterranean rivers several km long (San Miguel, Resistol and Chichicaseapan) which have been joined into a single system through fossil passages (Bochstiegell and Essex Girls passages) and has a length of over 33 km. Two other closely related systems, Zoquiapan (7 km) and San Andres (10 km) come within less than a kilometer from the main system. Apparently (no tracing experiments have been done) the Resistol

river joins the Chichicaseapan, receives the Zoquiapan water and enters San Miguel near its bottom, and from the sump that marks the end of San Miguel the water enters San Andres near its terminal choke.

The main resurgence for the system has not yet been located. Two large overflow resurgences, located on both sides of the northernmost spur of the Cuetzalan mesa, and active only in flood, are the only known outlets for the system. One of them, Cueva de Alpazat, has been explored for over 7 km, heading upwards towards the upper systems.

Most cave development is of the drawdown vadose type, although many of the smaller passages show evidence that they frequently function in flood spate conditions, with all limestone surfaces scalloped and conglomerate and chert layers standing out in relief. Surface streams flowing over the Cahuwas conglomerate flow northwards (down-dip) until reaching the base of the Taman limestone, and sink into sumideros. The main entrances to all the caves are these sumideros. As several underground streams join into ever larger passage, larger canyons are excavated into the conglomerate. Ceiling collapse is quite frequent, especially near the lowest levels of the upper caves, where stream size is large, and therefore passage cross sections are too big for the thinly bedded Taman limestone to sustain.

Fossil passages, especially in the Chichicaseapan and Resistol streams, record a complicated down-dip migration of the active streams, which open new routes that rejoin the older ones lower down. Since the older passage had been excavated deeply into the conglomerate, the arrival of the water to its old route is usually through impressive cascades.

The morphology of most of the fossil and partially active passages in Alpazat, the overflow resurgence cave, suggest that they formed, at least initially, under shallow phreatic conditions, although certain portions of the cave still function frequently under vadose, flood spate conditions.

How Do Temperature, Humidity, and Carbon Dioxide Affect Epsomite Crystal Growth in a Cave?

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Caves are a delicate environment and have been damaged in the past due to carelessness and lack of ecological awareness about caves. To protect caves, one must understand the relationships between environmental factors and speleothem deposition. This experiment was done to find out how humidity, temperature, and carbon dioxide affect epsomite crystal growth and to assess how highways near caves and/or people may be affecting caves.

Samples of angel hair speleothem that was thought to be epsomite crystals were obtained from a cave in central New Mexico. Epsomite crystals were grown in several differing environments to determine growth rate under variable humid-

ity and temperature. Further experiments were done with pieces of the cave crystals to test their reactions to changes in their environment. X-ray diffraction was used to identify the crystals and the affects of the changes.

Variations in temperature and humidity caused change in both the cave sample (which x-ray diffraction showed to be mirabilite rather than epsomite) and the experimental samples. Both mirabilite and epsomite are very sensitive to even slight environmental changes so they can indicate possible early signs of potential danger to a cave, much as indicator species are to other ecosystems. [This poster won an honorable mention in the earth science category, New Mexico State Science Fair.]

Role of Groundwater in the Development of Pseudokarst Terrain in the Pikes Peak Granite, Colorado

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Sinking streams, blind valleys, towers, natural arches, steepheads, poljes, underground streams, and caves provide the Lost Creek drainage, an area entirely within the Tarryall Mountain batholith of the 1.1 Ga Pikes Peak Granite, with the distinctive appearance of karst. Seven caves, all containing streams, are known within the drainage. The longest is over 600 m long. Surfaces are up to 60 m above the cave streams and several of the caves have extensive soil and forest covers.

The granite prominently displays a strong joint system with steep northeast and northwest sets and a sub-horizontal set, resulting in sub-orthogonal joint sets. Differential subsurface weathering by groundwater moving along the joints decomposed the granite forming grus. Near the surface, weathering along all three joint sets resulted in rounded boulders entirely engulfed by grus. At greater depth and in areas lacking the sub-horizontal, sheeting joints, grus formed along the vertical joints. Surface erosion easily removed the grus leaving behind scoured canyons in bedrock with boulder roofs. Through this two-step process of weathering and erosion, caves were formed that easily accommodate sinking and underground streams. Through the same process, blind valleys, towers, natural arches, steepheads, and poljes were formed.

Groundwater weathering occurred primarily from the chemical alteration of biotite to hydrobiotite and vermiculite in the presence of water with an accompanying volume increase up to 40%. The physical expansion fractured the surrounding solid rock. Frost shattering during freeze-thaw cycles further disaggregated the granite above the frost line in this alpine setting.

The distribution of caves and pseudokarst features is controlled by joint density, the concentration of biotite in the

granite, and the comparative rates of subsurface weathering and surface erosion.

Phosphate Minerals in Yarimburgaz Cave

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Yarimburgaz Cave is the oldest archeological site in Turkey. Lower Paleolithic artifacts and the remains of extinct fauna, especially *Ursus deningeri*, have been recovered from the lower entrance chamber of this solutional cave formed in limestone of Eocene ago. Diagenesis plays an important role in the development of the stratigraphic sequence, phosphatization is extensive in the entrance chambers where the archeological materials are found and in the cave interior. The site is important because it has the potential to shed more light on the history of human movement through and paleoenvironmental conditions in the Black Sea-Marmara region in the middle Pleistocene.

In the cave interior recent bat guano reacts with the limestone bedrock and clayey fill to form a range of minerals whose components are primarily Ca, S, and P, with variable presence of Al, Si, K, and Fe. Gypsum is common, and is usually closely associated with intermixed Ca-S phosphates. In the lower entrance chamber diagenesis is evidenced by the widespread occurrence of cemented zones. The cements are most crandallite and montgomeryite in the lower clayey units, and dahlite or hydroxyapatite in the younger sediments that underlie breakdown-rich layers.

The purpose of this poster is to present SEM photographs of some of the mineral associations and the corresponding EDS (elemental) and XRD analyses in order to trigger discussion about factors controlling phosphate mineral formation and stability. Of particular interest is whether the presence or absence of certain minerals can provide useful information about environmental conditions within the cave.

A Hydrated Uranyl Vanadate Mineral from Spider Cave, Carlsbad Caverns National Park, New Mexico

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A hydrated uranyl vanadate has precipitated as decimicron to millimeter-sized crystals in Spider Cave, Carlsbad Caverns National Park. Crystals are canary yellow and plate-like; they commonly consist of laths shaped like "playing cards" standing upright in a botryoidal coating of opal. Metatyuyamunite [$\text{Ca}(\text{UO}_2)_2(\text{VO}_4)_2 \cdot 3\text{-}5\text{H}_2\text{O}$] was identified by X-ray diffraction

(XRD) and scanning electron microscopy. Data from XRD indicates that Spider Cave metatyuyamunite using the orthorhombic unit cell has dimensions of $a = 10.397(4)\text{\AA}$, $b = 8.403(2)\text{\AA}$, $c = 16.692(12)\text{\AA}$.

Uranium and vanadium compounds may have initially been deposited within siltstones and dolostones in the Permian Yates Formation of the Artesia Group, the same formation in which Spider Cave is situated. Association of hydrated uranyl vanadate crystals with secondary opal on breakdown blocks, floor deposits, and speleothems in Spider Cave suggests that after speleogenesis and subsequent lowering of the water table, hydrated uranyl vanadates have precipitated from vadose solutions enriched with uranium, vanadium, and silica. The silica was probably derived from clays and/or clastic silts and sands of the Yates Formation.

This is the first report of uranium mineral deposition within caves of the Guadalupe Mountains.

INTERNATIONAL EXPLORATION SESSION

Reconnaissance Exploration in the Sierra Mixteca Alta, Oaxaca, Mexico

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The Sierra Mixteca Alta, a high mountain range within the Sierra Madre del Sur in central Oaxaca, México, has extensive limestone outcrops but little is known and nothing is documented about its karst development and cave potential. A small expedition of cavers from Colorado and Oaxaca explored the region last winter and found the area worth further investigations.

The remote *municipio* of Itundujia had been visited four previous times by small teams of U.S. cavers but each group had found the local people extremely uncooperative and access to the caves denied. This most recent team, including two official representatives of the state of Oaxaca, was also denied access to the area caves but they were able to determine the nature of the hostilities among the local people.

In the *municipio* of San Miguel el Grande, the team explored five new caves. Exploration was stopped in each cave by recent sediment fills that have resulted from severe soil erosion in the Sierra Mixteca Alta.

Further north, the team learned of several caves in the *municipio* of Nunuma but they were not explored due to

limited time and delicate political relations. Nearby, in the *municipio* of Yosonicaje, the local people and officials were warm, interested, and supportive of our interest and shared several caves with us. This town was determined to be the best objective for further efforts and the Oaxaca and Colorado cavers hope to continue an alliance in exploring them.

The Exploration of Kalmanshellir, Iceland, 1993

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During July 1993 a joint Icelandic-American expedition explored and surveyed the Kalmanshellir lava tube system of west-central Iceland. Although segmented at nearly forty ceiling collapses and several lava plugs, the length of the cave exceeds four km, making it the longest known cave system in Iceland. The expedition was a joint project of Hella-rannsóknafélag Íslands (the Icelandic Speleological Society), the National Speleological Society, the York Grotto, and Speleo-Research Associates.

The Kalmanshellir cave system is formed in a single lava flow unit near the origin of the Hallmundarhraun lava flow. This lava flow also contains the Surtshellir-Stefánsshellir lava tube system (previously the longest cave in Iceland). Víðgelmir (the most voluminous cave in Iceland), and nine other smaller caves. The depth of Kalmanshellir is only about 50 m and the end-to-end distances is nearly two km. A portion of the cave was previously explored by local farmers and Icelandic cavers. Several cave segments contained long lava soda straw stalactites (some exceeding a meter in length) and tall lava stalagmites.

Primary obstacles to exploration of Kalmanshellir included the remote location and the subarctic environment. These obstacles were overcome by a well-organized team using 4-wheel drive and 6-wheel drive vehicles and with equipment usually employed by high-altitude mountaineering teams. Cave survey accuracy was hindered by the strong magnetic effects of iron in the lava cave walls, but was overcome by foresight-backsight averaging underground coupled with surface theodolite surveys to accurately locate each surface collapse.

In addition to the exploration and survey of Kalmanshellir, some expedition participants also surveyed Leiðarendi (600m), visited the caves of Surtshellir, Stefánsshellir, Víðgelmir, and Hallmundarhellir, and because the first international team to descend the 120 m deep Þríhnúkgígur Pit.

**Hokeb Ha, Belize:
Exploration and Research with the
Jason Foundation Expedition V**

T.E. Miller

*Big Cyprus National Preserve and Department of
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Blue Creek's impressive exit in southern Belize was used by the Maya of the Classic Period. Modern mapping and exploration began in 1979 by McMaster University (Canada) cavers led by Tom Miller and John Wyeth. In the 1980's Miller and Wyeth, aided by Logan McNatt, explored the river completely through to the upstream entrance. In 1993-94, the *Jason Foundation for Education* supported surveys by Miller, Wyeth, and Carol Vesely that increased the known length to more than seven kilometers.

In March, 1994, 60 hours of live TV were broadcast during the Jason Expedition V from the cave, tropical rainforest, and nearby reef, via satellite to educational downlinks in North America and England.

Contemporaneous with the broadcast, flow [24°C] from the cave was gauged [350-1500 L/s], and stream, pool, and stalactite waters were analyzed with a Hach spectrophotometer and titrator. The waters were generally bicarbonate, calcite-saturated with pHs of 7.5-8.2, and dissolved solids of 300-500 mg/L. Some pools contained phosphate and nitrate levels exceeding 1-5 mg/L (attributed to bat colonies), but nutrient levels were generally low. Traces of dissolved sulfate, iron, and copper were found.

Blue Creek Cave developed as the White River abandoned an impressive limestone gorge. At least 4 progressively-abandoned levels developed in the brecciated limestone, most of which are still swept periodically by floods exceeding 30 meters in depth. Large "bellholes" and bell basins are common features of the cave; most breakdown is eroded and reworked speleothem.

The Purificación Karst in 1994

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Purificación is a large karst area located in the state of Tamaulipas in northeastern Mexico. Cavers began investigating the area in 1971, and since 1977 intensive exploration has taken place under the banner of the Proyecto Espeleológico Purificación. In 1993 and 1994, six expeditions resulted in extensions to the two longest caves in the area. In Sistema Purificación, Mexico's longest cave, a March 1994 underground camp resulted in 2500 meters of new passage surveyed. A dive in the bottom sump in May 1993 resulted in a 50 meter increase in the depth to 955 meters. To the southeast, 32-kilometer-long Cueva del Tecolote was the site of a 10-day underground camp in March 1993, during which 4000 meters

were mapped. Across the varied terrain of the Purificación Karst, the PEP cavers have been conducting reconnaissance of both cave entrances and interesting karst features.

**The Cave of the Rio San Ramon,
Huehuetenango, Guatemala,
March-April, 1992**

Steve Knutson

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In the Spring of 1992 an NSS Expedition visited the "Puente de Tierra" north of Barillas in the Department of Huehuetenango in Guatemala. The Puente is formed with the submergence of the Rio San Ramon for a distance of some 0.7 km. A through-trip of the cave was accomplished with some difficulty, requiring some 1200 meters of rope for a cave of about the same length. The dry season river flow was estimated at some 400-500 cfs.

**The Granite Karst of Atherton
Tablelands, Queensland, Australia**

Larry Flemming*, Carl Snyder,
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Granite Gorge Park in Queensland Australia exhibits many features typical of soluble rock including a short cave with active stream, and surface features which are similar in appearance to slickrock. While the system is far less complex than some previously reported granitic karst systems in the eastern US, the solution like features are more obvious.

**Cueva del Mano, Exploration of the
Resurgence of Cueva Cheve,
Oaxaca, Mexico**

Carol Vesely

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Cueva del Mano is located on the Rio Santo Domingo in the Sierra Juarez and is the resurgence for Cueva Cheve, the deepest cave in Mexico. Prior exploration had resulted in over six kilometers of mazy, well-decorated passages leading a kilometer south into the mountain towards Cueva Cheve. In April 1994, eighteen cavers spent a total of 12 days camped in the Rio Santo Domingo canyon continuing the exploration of Cueva del Mano and locating and exploring several other caves on both sides of the canyon. Over three kilometers of additional passage was surveyed in Cueva del Mano and the cave was extended farther south by over a hundred meters. Underwater passages in Mano were also pushed with over 870 meters of beautiful, clean borehole and mazy side passages surveyed. Large formations were discovered submerged twelve

feet below river level. Many leads remain both above and below water.

**The Semuc Champey, Alta Verapaz,
Guatemala—A River Cave Paradise**

Steve Knutson

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Tzemooc Cham-pe is K'ek chi for, roughly, "place of incredible arousal" and indeed it is: travertine deposition has bridged the Rio Cahabon for 300 meters and formed beautiful pools amidst the tropical forest. An NSS Expedition attempted a through-trip of the river cave beneath the travertine in April, 1993, but found that, despite the dry-season low flow of some 400-500 cfs, the cave is sumped for about 40 meters. The sump was reached from both ends.

Mixtlancingo, the Place of Clouds

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In the high mountains of the state of Guerrero the Mixtlancingo River, born in the valley of Coxtlahuacan, traverses a series of dolomite ranges through a series of spectacular caves. Most of the surface course of the river is in the bottom of a narrow gorge with many cascades. From the nearby ridges, the surface course can always be located by a faint mist caused by these cascades.

This area was first visited in December 1992, when the entrances to Primer Resumidero, Segundo Resumidero and Resumidero Chico were located. Since then, several trips have followed, in which we have managed to explore a significant part of the system. Primer Resumidero, 700 m long, was first traversed in January 1993, through a spectacular underground canyon, and involving the rigging of 8 cascades and several traverses, to resurface at the bottom of the narrow gorge that leads to Segundo Resumidero. Since then, Segundo Resumidero has been mapped, through 10 difficult cascades, for 1.5 km of spectacular underground canyon, and exploration has stopped at the top of another series of cascades. Resumidero Chico, which drains a small stream, was explored in December 1993, for 500 m to a sump.

**Caving in Guizhou Province,
People's Republic of China**

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Southwest China contains one of the largest unexplored Karst areas in the world. Since 1991, the China/USA Caves project has been organizing cooperative expeditions with Chinese cavers from the Guizhou Normal University, Guiyang, Guizhou, PRC. Most recently a small expedition took place in March 1994. During this expedition, a connection was made between two of the caves whose survey was begun on the earlier expeditions. The problems of organizing caving in China (permission, transportation, accommodation), and plans for continuing this project in the future will be presented.

**The Cave of the Rio Canlish,
Alta Verapaz, Guatemala, April 1994**

Steve Knutson

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It was thought that the Semuc Champey, as a river cave formed when a spring deposited travertine that bridged the river for some 300 meters was a unique feature for this part of and perhaps the whole world. Scouting in April, 1993, however, turned up another, only 20 km from the first. This is the submergence of the Rio Canlish for about 1 km, straight line. The resulting cave was the objective of an NSS Expedition in April of 1994. The river is some 20-30 cfs dry season flow.

Yerba Buena, Chiapas, Mexico

Don Coons

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Ruben Comstock

Yerba Buena, Chiapas, Mexico

The Yerba Buena Cave Project completed its fifth season as a resounding success. In total, project members have discovered and surveyed over 25 kilometers of cave, with a combined vertical extent of more than a mile. The largest discovery of the season was Aire Fresco, a 5+ kilometer system forming the main drain of the mountainside. Much more remains to be done.

BIOLOGY SYMPOSIUM

Biodiversity and Conservation of North American Cave Faunas: An Overview

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The species diversity of cave faunas varies geographically, environmentally, and phylogenetically. Biodiversity generally decreases from the tropics to the boreal regions, but cave faunas do not necessarily follow this pattern. For example, cave bat diversity is highest in the tropics, but groundwater biodiversity is highest in large karst aquifers, like the Edwards Aquifer of Texas. Terrestrial cave invertebrate diversity probably depends more on geologic-physiographic complexity and the age of a karst area than on climate. High species diversity, however, rarely is found in desert or boreal areas. Specific examples from Belize, Mexico, the United States, and Canada are given.

Being rare is not the same as being endangered and being common is not the same as being abundant. In Texas, examples abound of rare cave species that probably are not endangered yet, whereas some fairly common species in urbanizing areas are endangered. It can be argued that some species that are "abundant," such as the Mexican free-tailed bat, are threatened or endangered because of their specific ecological requirements and their dependence for birthing on relatively few, large, but vulnerable, caverns. Other bats, such as *Myotis velifer incautus*, have been driven out of many caves in Texas but seem to be more ecologically "flexible" than freetails.

The conservation of cave and karst faunas may be most critical to human welfare in the tropics, where certain bats are critical to forest ecology, and in major karst areas, where maintenance of water quality and abundance coincides with good karst management. Recent work in Alaska has demonstrated the connection between karst conservation and good forest management. Most cave species are of no immediate economic importance to humans, but neither are most large, attractive species that are more popular. Conservation at the species level is useful for several reasons to be discussed.

Centers of Biodiversity in Caves

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While there are likely tens of thousands of cave-limited species world-wide, most caves contain only a handful of species. In most areas, even high diversity caves contain only 10 to 20 species at most. The exceptions, such as Mammoth

Cave in Kentucky, have usually been explained on the basis of particular historical events (e.g. glacial maxima) occurring in unique geographical positions (e.g. distance from glacial boundaries). However, some exceptionally high-diversity cave and karst areas, most notably Movila Cave in Romania, Bayliss and other "bad air" caves in Australia, the Edwards Aquifer in Texas, and Lucayan Caverns in the Bahamas, share an important feature—"redox" environments and, most likely, sharp redox boundaries. Redox environments are areas of high productivity, often the result of chemoautotrophic bacteria. This relatively high productivity may allow the development of a diverse cave-limited fauna, given appropriate geographical and historical conditions.

Biodiversity of Subterranean Amphipod Crustaceans: Global Perspective and Strategies for Protection

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Amphipod crustaceans are among the most abundant, widespread, and taxonomically diverse invertebrate groups found in subterranean groundwater communities. The vast majority are stygobionts, which by definition are species generally restricted to subterranean waters and showing some degree of troglomorphy (e.g., loss of eyes and pigment). The world's subterranean amphipod fauna is composed of approximately 750 species, which are distributed among 36 families and 138 genera. However, 12 families contain about 94 percent of all stygobiont amphipods, and the families Niphargidae, Crangonyctidae, Hadziidae (complex) and Bogidiellidae are the most important with respect to the numbers of stygobiont species they contain. The two largest genera—*Niphargus* (predominately European) and *Stygobromus* (predominately North American)—are composed exclusively of stygobionts and each has over 100 described species.

Although many regions of the world have significant diversities of stygobiont amphipods, the most remarkable species richness has been documented to date in the central and southern European-Mediterranean and eastern and southern North American-West Indian regions. Both of these regions have extensive karst terrains that remained unglaciated during the Pleistocene and were exposed to marine transgressions in the south during the Cretaceous and/or Tertiary. An essential first step in conservation and protection of stygobiont amphipods, and for other groups as well, is to document the biodiversity of these organisms, both regionally and globally. Data on taxonomic diversity and phylogenetic relationships are critical to the development of protection strategies for rare, threatened, or endangered subterranean faunas and their habitats.

Caves and Bats

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Bats, aided by their ability to navigate and orient in the dark using echolocation, are the only vertebrates that have successfully exploited caves (and increasingly, abandoned mines) for permanent shelter. From tree line to tree line, these structures supply bats in most major ecosystems with relatively permanent and climatically-controlled summer and winter homes, maternity and bachelor roosts, or predator-free environments in which to mate and feed, or rest during long migrations.

The distribution of cave-dwelling bats varies predictably with the geographic distribution of caves. On a smaller scale, cave-specific attributes (physical dimensions, topography and microclimate) determine the presence or absence of bats as well as faunal composition and characteristics.

In North America (excluding Mexico) more than half of 43 bat species use caves during some part of the year. However, only about 5% of the 40,000 caves in the U.S. provide suitable roosting conditions for these animals. Consequently, caves can be a crucial resource for the survival of some species. For example, fewer than 10 caves house 95% of hibernating Gray Bats, an endangered species. Fewer than 25 caves in the southwestern states are home to most of the millions of Mexican Free-tailed Bats that migrate to the U.S. from Mexico every spring to give birth.

Bats reach their greatest number and diversity in the tropics. In Central America and South America, where bats are the dominant land mammals, more than 100 species can occur together in an area. Caves in these areas can provide homes for a large number of species, including many that pollinate and disperse dominant rainforest and desert plants.

Guano produced by cave-roosting bats is a major energy source for unique, and highly adapted, cave communities around the world. Guano accumulations from large bat colonies, particularly in tropical and subtropical climates, provide a source of income for local inhabitants.

Worldwide, cave-dwelling bats face increasing threats to their survival. To blame are: habitat destruction, vandalism and disturbance, pesticides, and inadequate wildlife protection laws. Tropical species face additional threats from poachers and misguided vampire bat eradication programs.

The Impact of Urbanization on Endemic Cave Fauna in Travis and Williamson Counties, Texas

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An estimated 38 species of terrestrial troglobite are endemic to Travis and Williamson Counties (and immediate adjacent limestone outcrops in Burnet and Hays Counties). These include seven species on the U.S. Fish and Wildlife Service List of Endangered Species: the Tooth Cave spider *Neoleptoneta myopica* (Gertsch), the Tooth Cave pseudoscorpian *Tartarocreagris texana* (Muchmore), the Bee Creek Cave harvestman *Texella reddelli* Goodnight and Goodnight, the Bone Cave harvestman *Texella reyesi* Ubick and Briggs, the Tooth Cave ground beetle *Rhadine persephone* Barr, the Kretschmarr Cave mold beetle *Texamaurops reddelli* Barr and Steeves, and the Coffin Cave mold beetle *Batrisodes (Excavodes) texana* Chandler. The geologic factors responsible for the endemism of this fauna include faulting and canyon incision. Maps and demographic data will be used to demonstrate the impact of the rapid growth of Austin and adjacent cities on the endemic cave fauna. A brief overview will be given of attempts to conserve the cave fauna.

Biodiversity in Caves: Imperiled or Not?

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In recent decades it has become apparent that anthropogenic perturbations are not restricted only to surface ecosystems. Rather, evidence continues to mount globally that various caves, springs, cenotes, blueholes, and anchialine and various crevicular habitats, as well as regional groundwater have become altered by surface activities of humans. Although the Federal Endangered Species Act has resulted in numerous cave-adapted species being listed and "protected," examples of extirpated populations, such as the blind shrimp *Palaemonias alabamiae* Smalley and the Gray Bat, *Myotis grisescens* (Howell) in Shelta Cave, Madison County, Alabama, demonstrate that simply being listed may not afford adequate protection. On a grander scale, numerous North and Central American karst systems as well as those in many locations in the western Atlantic (e.g., Bermuda, Bahamas) have been severely disturbed. Horrendous management problems exist at all levels and often mismanagement is realized long after damage has occurred. An additional problem is that very little is known about so few cave species; those animals recognized represent only a fraction of projected totals for extant or even extinct forms.

In addition to halting surface perturbations in karst areas,

efforts should be made to encourage detailed taxonomic, life history, and ecological studies of karst (surface and subsurface) ecosystems. Additional cave biologists are needed in order to ensure the study and documentation of spelean diversity. Without adequate information concerning physicochemical and biological parameters, decisions for appropriate short and long term protection and management of karst ecosystems will be ineffective.

EQUIPMENT AND TECHNIQUES SESSION

Coupling Mineralogical Database Information with Advanced Three-Dimensional Cave Surveying

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CSS_Surveyor is an interactive, three-dimensional modeling tool for displaying mineralogical and arbitrary user-defined database information onto cave survey plots. The program is also a new-generation cave survey program, providing advanced graphics and an easy-to-use user interface. Through Open-GL, the program will run on almost any workstation, as well as the PowerPC line of processors.

CSS_Surveyor is unique in that it provides an easy to use interactive method for graphically illustrating the relative locations within the cave survey plot of mineral and speleothem data. For cave exploration, the program can display various user-defined attributes such as leads, water, rope drops, etc.

In addition to providing the ability to select and zoom into any region of the cave and provide the usual suite of cave surveying functions, the program also provides the user with 3-D trackball interaction within a user-selected region of the cave. Slowly rotating selected passageways in 3-D can often provide more insight than that from an arbitrary plan or profile view. Of course, the program also allows any plan or profile view to be specified.

CSS_Surveyor is built upon an easy-to-use graphical user interface which makes full use of menus, buttons, and graphical displays, which provide accurate and easy interaction with the cave model and attribute databases. CSS_Surveyor currently accepts data in KARST, COMPASS, and our CSS (for Cave Survey Standard) formats, allowing data portability from other tools currently in use.

A 3D Symbol Set for Stage-4 Cave Maps

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A computer program called Interactive Cave Map (ICM) is being used by the author to explore the application of interactive computer graphics to the generation and display of Stage-4 cave maps, i.e., cave maps designed to be viewed on the computer graphics screen. ICM display four basic types of information: Traverse Lines Information (TLI), Passage Walls Information (PWI), SYmbols Information (SYI), and AuXillary Information (AXI). This paper concentrates on SYI.

The symbol set, implemented using parametrized icons, allows the depiction in 3D of objects appropriately addressed by the "Basic Cave Map Symbols" of the 1976 NSS Standard, including: Passage Features, Speleothems, Floor Materials, and Miscellaneous. It should be noted that not all "symbols" in the 1976 NSS Standard address objects found in caves. Some are attempts to convey other types of information, e.g., cross sections and ceiling heights attempt to convey PWI, survey stations to convey TLI, and north arrows and scales to convey AXI. The icon parameters include three offsets from a survey station (for placing the symbol), three factors (for scaling the symbol), and three angles (for orienting the symbol).

Hardcopies of the maps of Corkscrew Cave (an artificial cave used for testing the computer program) and of Cueva Catanamatias (a real cave in the Dominican Republic) are used to illustrate the symbol set.

The OTR Compass Course

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In 1988, I took over the responsibilities of running the compass course at OTR. This course is an eight-station, seven-shot course, where contestants compete to see who can close a loop with the smallest error. Each year the layout of the course is changed, and there are often severe vertical shots incorporated into the design of the individual courses.

The end result of these five years is that I have managed to collect a good deal of data on the instruments most cavers use to survey in caves. Predominant among these instruments are Suuntos; Sistecos are a poor second and Bruntons a poorer third. I have tossed out all the "bad" data sets, averaged the azimuths and inclinations for each individual shot, compared the individual azimuths and inclinations to these averages, calculated a difference for each shot, and then averaged these differences. The end results are that I have found Suuntos to be the most accurate of the three instruments and that the clinom-

eters are more accurate than the compasses.

And how much do most cave surveying instruments deviate from these averaged norths and horizontals? The compasses were typically 1 degree off the averaged north, and the clinometers 0.4 degrees off the averaged horizontal. The need for compass courses is obvious once a graph of all the data is viewed.

A Lighter, Safer Mitchell System

Cindy Heazlet

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Backpacking to remote vertical mountain caves requires an ascender system that is light, compact, yet relatively safe. The Mitchell System shown in the NSS publication *On Rope* is too heavy and large for this application. Mountain cavers have eliminated the use of sewn webbing for foot loops, exchanged tubular webbing for static line, added safety tethers, and constructed ultra-light seat harnesses for a smaller, lighter, yet "safe" system. Each modification to the Mitchell System can be made independent of all other modifications. The talk will consist of: (1) A discussion of each of the modifications. (2) A demonstration on building an ultra-light, yet safe seat harness. (3) Demonstration of how a safety tether can guard against the more common Mitchell System failures, and add to the comfort of the system.

Cave Rescue Organization, Accidents, and Incidents in Cuban Caves

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Speleological Society of Cuba

Larger caves in Cuba are horizontal, and even though most have several levels, connection between them is possible without many difficult climbing operations. Mostly our bigger systems are of fluvial genesis, and many of them are at some time of the year completely or partly occupied by underground lakes or running streams. For this reason, for years accidents and incidents were mainly related to water. With a seven-month rainy season in which frequent tropical storms develop, the Speleological Society of Cuba (SEC) had less than 30 rescue calls before the 80s.

With the arrival of new techniques such as single rope, cave diving, and others, a group of previously inaccessible caves were attacked, and the character of accidents changed. Now the SEC has the unpleasant experience of recovering dead bodies of members.

Even though most of the groups with problems try to rescue themselves, exploration of vertical caves and problems with bad quality of equipment made necessary a rescue program.

The Speleological Society of Cuba has a National Rescue Commission, with a Central Medical Group. Each one of the 14 Cuban provinces and the Special Municipality of the Isle of Youth (Isle of Pines) has a rescue team. There is a program of instruction with an annual first-level course, and a second-level course has been organized for 1994.

The absence of statistical records and the different groups of people participating in rescue operations in caves, mountains, canyons, and other wild places in Cuba make it difficult to have a complete record of these kinds of problems. This is a first step.

Locating the Cave Entrance

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Recently, I have completed a publication on the caves of a drainage area in Greenbrier County, West Virginia. It has become painfully obvious that most cavers—including many experienced cavers—have no idea what to describe while locating caves in a given area or above the mega-monster-cave.

The proper method—which should prevent multiple trips to the cave to redescribe the entrance—should include not only marking the cave location precisely on a topographic map, accurately determining the coordinates, but also providing a good, written description of where the cave is located and of the appearance of the cave entrance. There is no such thing as too much of a written description.

The written description of the cave location should include items such as: Is the entrance north or south of a fence?, what trees or obvious rock outcrops are nearby?, and how far and what direction is the entrance from the nearest road, valley bottom, or stream? Give azimuths to obvious locators—e.g., houses, barns, junkpiles, etc., and include a sketch of where the cave is located.

The written description of the appearance of the cave entrance should include: The depth, diameter, and shape of the sinkhole, the diameter and shape of the cave entrance, is the cave entrance in bedrock or soil, are there any streams which flow into or out of the cave entrance, what is immediately above or below the cave entrance, and—if necessary—are there any interesting features in the cave entrance. This may include a picture of the cave entrance.

To summarize, it is very important to keep lavish written records of where each cave is located and of the appearance of the cave entrance. The bottom line is overkill, overkill, and overkill. The other option is 501 trips to the same cave entrance to re- and redescribe its location and appearance.

SOCIAL SCIENCES SESSION

The Importance of Caves in Non-Karstic Regions of Guatemala

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Recent studies in non-karstic regions of the Maya highlands of Guatemala have uncovered the existence of man-made, man-modified and pseudo-karst caves. The caves were excavated from volcanic or volcanically-derived Tertiary and Quaternary age rocks, with construction methods varying according to rock hardness. The caves, which vary in length up to 128 m, are associated with site centers or shrines of particular ritual importance. These features constitute a previously unrecognized form of Maya architecture. Coupled with recent investigations in the Maya lowlands which found natural caves being incorporated into site architecture, the discovery of these man-made features suggests that the presence of a "cave" is absolutely necessary in the process of validating sites.

The Wind Cave Feud

Nancy E. Holler

Turn back the clock for an action-packed ride through the 1890's and 1900's at Wind Cave, South Dakota. Possession of the cave focused on two families—the Stablers and the McDonalds, and their common interest in gaining wealth quickly transformed into a raging feud between them. Numerous accounts of gunfights, publicity stunts, house torching, bitter verbal exchanges, cave specimen collecting, and *lots* of newspaper publicity are just a few events that contributed in the battle for Wind Cave gaining nationwide attention and having such a rich and colorful history.

Historical Study and Perspective View of Tourist Caving in Cuba

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 Cuba and Sociedad Espeleológica de Cuba*
 José Luis Gerhartz Muro
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The history and development of the tourist caves of Cuba will be discussed, and a diagnosis will be given of the actual situation of these resources through a critical evaluation of the errors committed during the work of adapting the caves and their surroundings, presenting a series of recommendations to

better organize trails, lighting, handrails, and so on, in order to make the caves more attractive. Also described will be some established tourist areas in Cuba that have exploitable speleological potential. Examples of how, in several cases, these caves can be used will be presented.

Finally, recommendations will be offered for the development of tourism in Cuban caves. [Translated from Spanish.]

The Marginella Burial Cave Project: A Preliminary Report

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A study of the Native American burial caves of Virginia is in progress. Field studies over the past year and a half have documented a number of previously unrecorded Native American burial caves in Virginia. All but one of the Virginia burial caves have been subject to looting. Despite disturbance, important archaeological materials remain and looting continues at these sites and at undocumented sites. In an attempt at utilizing education to protect these resources, articles on their sensitivity and the consequences of their destruction have been distributed to cave owners. A significant objective of the project is to spur enforcement of the laws that protect burial caves from disturbance, which constitutes a felony. Under permits, cosmetic salvage operations at these threatened sites minimizes the attractiveness of these caves to continued damage and provides significant physical information about the individuals interred and their cultural affiliations. Currently, project administrators are working to avert the destruction of one site by highway construction.

History of the Exploration of Sistema Huautla

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The caves of the Huautla plateau, Mexico, were suspected from aerial photographs in the mid-60's. Association for Mexican Cave Studies cavers began exploration in 1966 and it continues today.

There have been three phases of exploration. The initial exploration was in 1966-71 by AMCS and McMasters University, Canada, cavers. In 1967, the distinction of deepest cave in the Western Hemisphere came to Huautla and has remained most of the time since.

The second phase began in 1976 with discovery of deeper passages in Sotano de San Agustín. In 1977 the Huautla Project was formed to organize annual expeditions and conduct "full speleology."

The third phase began in 1982 with the split of the Huautla Project into two parallel efforts. One continued the exploration of the vertical caves of the upper end of the cave system. This

resulted in the March 26, 1987 connection of Nita Nanta with Sistema Huautla, establishing the cave as the world's third deepest. The other concentrated on the lower end of Sistema Huautla through cave diving.

Sistema Huautla has an abundance of deep routes. There are 15 entrances and deep routes with depths over 600 meters, 700 meters, 800 meters, two over 900 meters, and two over 1,000 meters. Not integrated into the system are caves of 400 meters, two over 500, one over 600, and two over 700 meters in depth.

Published studies on cave science have included archaeology, geology, biology, paleontology, and hydrology.

A History of Woodlee Cave and Dry Cave, Grundy County, Tennessee

Joseph C. Douglas

#107, 4444 Cullen Blvd., Houston, Texas 77004

Woodlee Cave and Dry Cave have rich and varied histories. Dry Cave was explored by Native Americans in the late Archaic period, while Woodlee Cave was an occupation site in the middle Woodland period. After 1805 both caves were explored by white settlers, although few specifics are known. In the Civil War both were mined for saltpeter, and Woodlee Cave was apparently a significant source. Following the Civil War, the caves were frequently visited by the inhabitants of the valley, Northcutt's Cove, and occasionally by others. More is known about these visitors than previous explorers. Most of these were pleasure trips. The property changed hands over the years and the various owners will be discussed. After the turn of the 20th century both caves were used for utilitarian purposes as well as pleasure trips. Dry Cave was used as a root cellar, while Woodlee Cave contained a moonshine still. This paper will examine the history of the two caves through the 1930s.

BIOLOGY AND PALEONTOLOGY SESSION

Evolution and Dispersal in Texas Salamanders of the Genus *Eurycea*

Andy G. Grubbs* and Paul Chippendale

*P.O. Box 208, San Marcos, Texas 78667

Recent cave discoveries and laboratory studies of Texas cave salamanders have further advanced our knowledge about this interesting group. Several new species have been found in recently discovered caves north of Austin and the hydrologic systems they inhabit are being studied. Other discoveries from caves in Glenrose and Edwards limestone shed light on the dispersal potential of salamanders through conduits and across groundwater divides. DNA studies showing the degree of relatedness of different populations reveal two major groupings aligned with geographic distribution.

A New Species of the Subterranean Amphipod Genus *Paramexiweckelia* (Hadziidae) from Val Verde County, Texas, with Comments on Its Biogeographic and Phylogenetic Relationships

John R. Holsinger

Dept. of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529

During fieldwork in the 1980s, Dr. Robert Hershler collected stygobiont amphipods from unnamed springs on the east side of Devils River about 32 km north of Del Rio in Val Verde, Co., TX. The samples contained numerous specimens of an undescribed species of *Paramexiweckelia*, and fewer specimens of *Seborgia hershleri* and *Stygobromus* sp. (*flagellatus* group). Prior to the present study, *Paramexiweckelia* was known only from a single species described from a resurgence in the Bolsón de Cuatro Ciénegas, Coahuila, in northern Mexico. The new species from Val Verde Country brings the total number of species of freshwater stygobiont amphipods in the family Hadziidae from continental North America, north of Yucatan Peninsula, to 10. *Paramexiweckelia* is the most primitive of the six regionally endemic hadziid genera of northern Mexico and Texas. It forms an "outgroup" to the other genera as indicated by a number of important plesiomorphic characters.

Morphologically, the two species of *Paramexiweckelia* are closely similar, but they are separated geographically by approximately 350 km and the Sierra Madre Oriental. The distribution track of this genus parallels in part the distribution tracks of another hadziid amphipod, *Mexiweckelia*, and two

stygobiont isopods—the cirolanid *Speocirolana* and stenasellid *Mexistenasellus*. These three genera also occur in both central Coahuila and south-central Texas. The discovery of yet another species of stygobiont amphipod in south-central Texas, associated with the Edwards underground aquifer, is further indication of the remarkable biodiversity of the marine-relict crustacean fauna that inhabits this extensive karst system.

Community Ecology of Three Central Texas Caves

William R. Elliott

Texas Memorial Museum;

12102 Grimsley Drive, Austin, Texas 78759-3120

In 1991, I began baseline ecological monitoring of LakeLine Cave, Thor Cave, and Testudo Tube, in Williamson County, Texas, under contract to the Simon Development Co., Inc. The studies were required by a permit issued by the U.S. Fish and Wildlife Service to mitigate the development of a shopping mall on an endangered species karst area near Austin. LakeLine Cave was set aside in a small preserve for the benefit of *Texella reyesi*, the Bone Cave harvestman, and *Rhadine persephone*, the Tooth Cave ground beetle. The company also acquired two other karst preserves and supported my studies.

The three caves have different communities and physical dynamics. The caves were wired with temperature-humidity sensors linked to digital data loggers and were visited monthly for over a year. During the visits species were inventoried in marked zones and temperature and humidity readings were taken with a high-precision digital thermometer. I found that the two endangered species have precise microhabitat requirements. Cave cricket emergences were studied for one year, including monthly four-hour counts and quarterly overnight vigils. I tracked the seasonal abundance of two to three species of crickets, daddy longlegs, fire ants, and other species to determine the minimal ecological requirements for a sustainable endangered species cave preserve. I found that raccoons and crickets contribute large amounts of nutrients to some caves and that *Peromyscus* mice consume large numbers of crickets. Fire ants are making inroads on Central Texas cave ecosystems. Data were accumulated showing some competitive exclusion between *Rhadine subterranea* and *Rhadine persephone*. Studies are continuing.

Effects of Septic System Outfall on Macroinvertebrate Populations and Their Food Resources

Kevin S. Simon and Arthur L. Buikema, Jr.

*Department of Biology, Virginia Polytechnic Institute
and State University, Blacksburg, VA 24061-0406*

The aquatic community in Banners Corner Cave, Russell Co., Virginia is affected by overlying septic systems. Impacted sites had low dissolved oxygen concentrations and

high conductivity, Cl^- , NO_3^- , and fecal coliform levels. High densities of *Caecidotea recurvata*, a troglobitic isopod, in Banners Corner Cave were suspected to be a result of organic enrichment by septic outfall. Isopod density, sediment organic matter, bacterial biomass, and fungal biomass were measured in reference and impacted sites. Isopod densities range from 3.0–74.6/m² with highest densities in moderately impacted and unimpacted sites. Heavily impacted sites had no isopods. Sediment organic matter ranged from 0.02–0.09 gC/g sediment and bacterial biomass ranged from 0.07–1.60 mgC/g. Sediment organic matter and bacterial biomass were significantly greater (one-way ANOVA, $\alpha=0.05$) in all impacted sites as compared to reference sites. Fungal biomass was negligible in sediments in all sites. Septic outfall generally reduced isopod densities, presumably by direct toxicity and reduction of dissolved oxygen. At moderate levels, septic outfall may increase food availability without toxic effects, but this did not occur often in Banners Corner Cave. High isopod densities appear to be due to presence of CPOM rather than organic enrichment by septic outfall.

Long-Term Ecological Monitoring of Karst Resources at Mammoth Cave National Park, Kentucky

Rick Olson

*Division of Science and Resources Management,
Mammoth Cave National Park,
Mammoth Cave, Kentucky 42259*

As part of a National Park Service initiative to expand resources management programs, Mammoth Cave National Park has been selected to develop strategies for long-term ecological monitoring of cave and karst resources. Key elements of the proposed watershed approach include synoptic and flood pulse water quality sampling, correlative biomonitoring of these same waters, and acquisition of land use and demographic data for each drainage basin. Ecotones at selected natural, modified natural, and artificial entrances will be equipped for continuous atmospheric monitoring, and periodic census data on both vertebrate and invertebrate populations will be collected. In the constant temperature zone, impacts from inadvertent abrasion, substrate compaction, vandalism, lint deposition, latrines, and food service will be monitored. Methods will include permanent photopoints, gravimetric measurements of lint accumulation, continuous atmospheric measurements, and periodic census of the terrestrial cave community.

Evolution of the Amphipod *Gammarus minus* in Caves: An Analysis of Time

Daniel W. Fong

Department of Biology, The American University,
Washington, D.C. 20016

The amphipod *Gammarus minus* is estimated to have invaded underground basins multiple times, from as early as 2 million years ago to about 100,000 years ago. There is evidence for directional selection in the evolution of troglomorphy in cave populations. These time estimates, however, indicate that observed rates of morphological change in *G. minus* are less than expected from neutral models. Eye size has evolved faster than antenna size, and may reflect that while the evolution of antenna size is due to selection, the evolution of eye size is due to additive effects of neutral mutation and selection. Genetic evidence also indicates that karst window populations of *G. minus* are derived from cave populations, and suggests rapid loss and re-acquisition of eye components. An hypothesis that eye reduction in cave populations may originally result from selection for mutations at the regulatory loci is proposed.

A Preliminary Study of the Invertebrate Cave Fauna of China

David A. Hubbard, Jr.

Virginia Cave Board, Box 3667,
Charlottesville, VA 22903

John R. Holsinger and Jun Zhang

Department of Biological Sciences,
Old Dominion University, Norfolk, Virginia 23529

During the XI International Congress of Speleology in 1993 we collected biological samples from five caves in two regions of China. Despite drastic alteration of four of these caves for tourism, limited collecting resulted in significant discoveries of invertebrate animals, including several undescribed taxa and new cave records for known species. A non-tourist cave near Guilin in south China and four tourist caves on the Liaoning Peninsula in northeastern China were investigated. The cave near Guilin yielded aquatic snails, ostracods, atyid shrimps, trichoniscid isopods, polydesmid millipedes, and dytiscid beetles. The shrimps, isopods and beetles represent new genera; most or all of the species collected from this cave appear to be troglotic. Collections from Liaoning caves included cyclopoid copepods, ostracods, amphipods, onychiurid collembolans, and campodeid diplurans. Some of these represent new species, others represent new cave records. The record for the stygobiont amphipod crustacean *Pseudocrangonyx asiaticus* is the first for the species from a Chinese cave (a previous collection was from a spring), whereas the record for *Gammarus nekkensis*, a non-stygobiont amphipod, is the first from a cave and also a significant range extension for this species.

The invertebrate cave fauna of China is very poorly known, but our preliminary sampling suggests a potentially significant biodiversity. Unfortunately, habitats in many large caves have been drastically altered or destroyed during development for tourism. We suggest that biological inventories be made in as many unaltered caves as possible and that government officials be urged to protect the most biologically diverse caves in their natural state.

Cave Vertebrate Paleontology in Texas

Rickard S. Toomey III

Illinois State Museum, Research and Collections
Center, 1011 East Ash St., Springfield, IL 62703

Of the many Texas caves from which bones have been recovered, approximately 30 have produced scientifically important vertebrate remains. These thirty caves are all located in central and Trans-Pecos Texas. The remains from these caves provide information both on animals that have lived in the area and on environmental changes the area has experienced. Notable vertebrate finds in Texas caves include well-preserved peccaries, turtles and scimitar cats from Friesenhahn Cave, a partial peccary "herd" from Laubach Cave, sloth dung from the Sloth Caves, and a long vertebrate-bearing sequence from Hall's Cave.

Deposition of most of the well-studied remains from Texas caves occurred during the last 25,000 years; however, one cave contains fossils between 750,000 and 1.5 million years old. The fossil vertebrates found in Texas caves include fish, amphibians, reptiles, birds and mammals. They range in size from small salamanders and mice to elephant-like extinct mammoths and mastodons. Bone in caves occurs in many contexts and gets into caves in several ways. The context in which it is found and the ways it got there are both critically important in evaluating the significance of bone in caves.

With careful collection and further study many other caves will probably produce important fossils. For this reason it is important to always be aware of the potential for significant vertebrate remains when exploring, studying, or conserving caves.

Those Damn Bones Are in the Way

Pat Jablonsky

604 Southern Sky, Carlsbad, NM 88220

As cavers begin to "dig" for caves more and more, they increase the odds that they will encounter bones of various animals. Most of the bones will be of recent vintage, but occasionally, cavers may encounter bones of extinct animals. When this happens what should be done? This presentation will address this issue and provide cavers with basic guidelines on what to do when bones are encountered, especially in regards to caves on Federal lands.

Late Quaternary Size, Range and Behavior Changes in Central Texas Bats

Rickard S. Toomey III

Illinois State Museum, Research and Collections Center, 1011 East Ash St., Springfield, IL 62703

Different species of bat have responded to the environmental changes of the last 25,000 years in different ways. Bat fossils from central Texas caves indicate that size changes, range changes and possibly behavior changes have all occurred. These changes are interpreted to be responses to changing environmental conditions.

Central Texas *Myotis velifer* have both increased and decreased in size (based on the length of the mandible and length of the lower molars) during the last 25,000 years. About 25,000 years B.P. they were approximately the same mean size as modern. By about 15,000 years B.P. mean size had increased by seven percent. During the last 15,000 years their size has gradually decreased to modern size. A preliminary interpretation of these changes is that they are responses to changing cave temperatures.

Pipistrellus subflavus, *Eptesicus fuscus* and probably *Tadarida brasiliensis* have all changed their geographic range during the last 25,000 years. Changes in *Pipistrellus subflavus* range are a response to changing moisture, especially to drier than modern conditions in the Middle to Late Holocene. Both *Eptesicus fuscus* and *Tadarida brasiliensis* probably changed geographic range in response to changing cave temperatures.

Changes in abundance of *Eptesicus fuscus* remains at Hall's Cave, Kerr Country, Texas may indicate a change in bat behavior. This change is probably a result of increasing cave temperature.

The Blue Lake Rhinoceros: A Caver's Perspective

Cato Holler, Jr.

P.O. Box 100, Old Fort, North Carolina 28762

Approximately 20 million years ago during the Miocene period, vast basaltic lava floods covered over 63,000 square miles of the Pacific northwest. During this time a small rhinoceros of the genus *Diceratherium* died in a pond of water and was subsequently covered by one of the lava flows. As the molten lava poured over the carcass, the water immediately chilled the flow forming a mold of the rhino's body. In 1935 the cavity was discovered high on a basaltic cliff at Blue Lake in east central Washington state. Several teeth and bones were still intact.

Although many cavers had heard of the cavity, it was surprising to learn that few had actually visited the site. An August '93 trip was made to survey and photograph the Blue Lake Rhino Cave, truly one of the world's most unique grottos.

Deep Cave Recovery Techniques for Paleontological Specimens

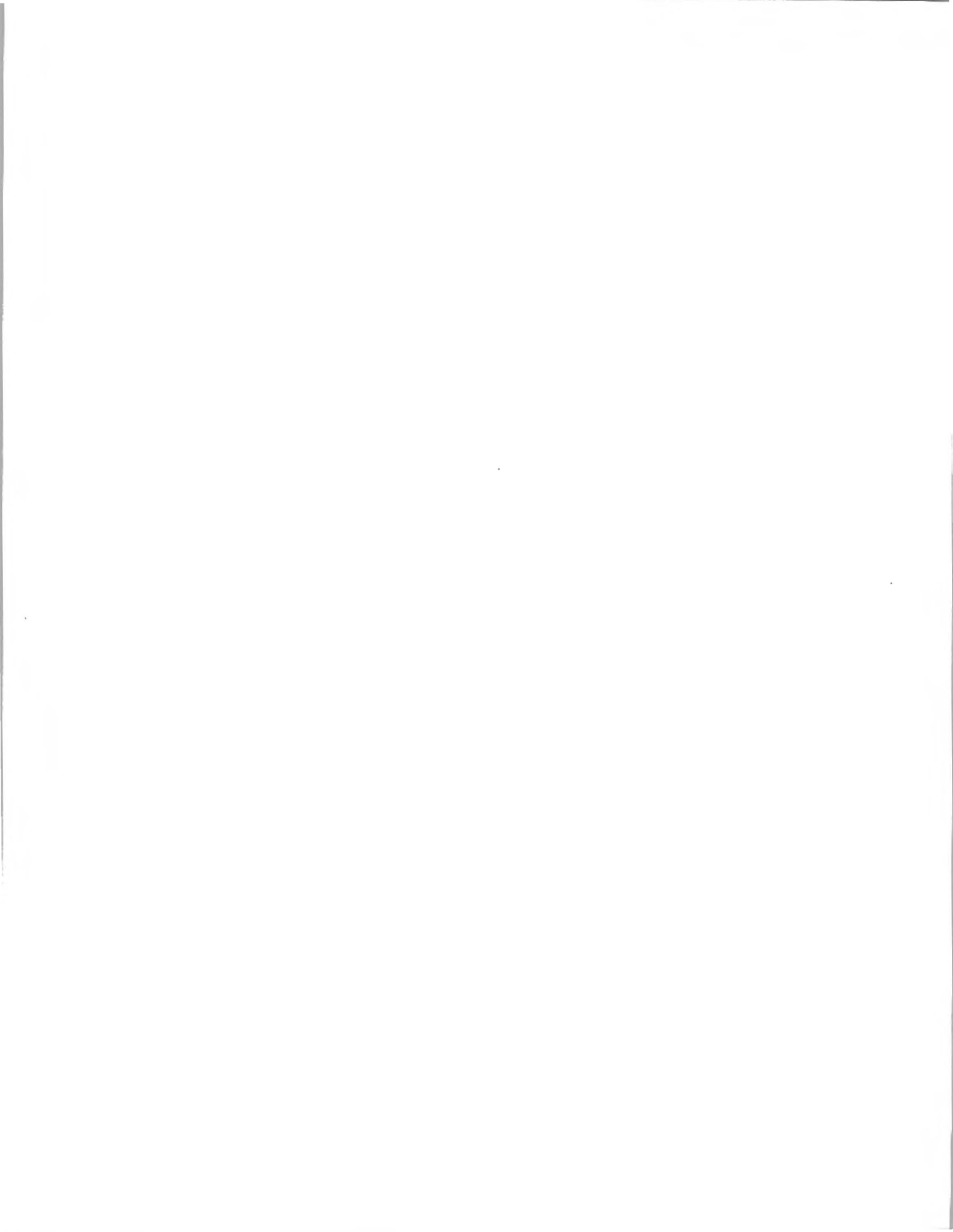
Patricia L. Jablonsky

Carlsbad Museum and Fine Art Center, 418 West Fox Street, Carlsbad, NM 88220

Caves and rock shelters are a rich source of paleontological, anthropological information and other materials of scientific interest. It is estimated that half of all Pleistocene materials in scientific collections are from such sources.

While most specimens are commonly found near entrances and are relatively easy to recover, over time, entrances may be severely altered or may collapse due to surface conditions. When this occurs, significant specimens are frequently moved by natural forces deeper into complex and or difficult to traverse cave systems.

Among items to be discussed will be the special techniques for recovery of deep cave materials utilized in recent excavation and recovery projects at Lechuguilla Cave, Carlsbad Caverns National Park, New Mexico. Due to the fragility of the Chiropteran specimens and the bulk of the larger mammalian specimen recovered, new and modified techniques were developed. Extra care was taken to comply with three major concerns of the Carlsbad Caverns National Park: minimal disturbance to Lechuguilla Cave; prevention of the introduction of alien materials; and full restoration of the sites in the cave.



TEXAS AND NATIONAL CAVE ORGANIZATIONS

Compiled by Bill Elliott

TEXAS CAVE RESCUE

210-686-0234 Call Collect

(24-hour number at Kreidler Funeral Home, McAllen. Ask for "Cave Rescue" or "John Kreidler" to initiate call-down for qualified cave rescue teams covering Texas and Mexico.)

National Speleological Society

2813 Cave Avenue
Huntsville, AL 35810-4431
205-852-1300

(Annual regular membership \$25, includes the *NSS News* and *NSS Bulletin*. Annual convention.)

American Cave Conservation Association

P.O. Box 409
Horse Cave, KY 42749
502-786-1466

(American Museum of Caves and Karstlands, *American Caves* magazine, educational workshops and conservation projects. Annual regular dues \$25.)

Texas Speleological Association

Box 8026
Austin, TX 78713
512-458-8760

(Annual membership \$15, includes *The Texas Caver*, *TSA Activities Newsletter*, and three meetings/workshops).

Texas Speleological Survey

12102 Grimsley Drive
Austin, TX 78759-3120
512-835-2213 (Dr. William R. Elliott)

(Publishes reports on Texas caves and karst areas, since 1961. Library, computer databases, map, text, and photo archives for the TSA).

The Texas Caver magazine

(See Texas Speleological Association)

Association for Mexican Cave Studies

Box 7672
Austin, TX 78713

(Publishes the *AMCS Activities Newsletter*.)

Proyecto Espeleológico Purificación

P.O. Box 8424
Austin, TX 78713

(Annual PEP membership \$15, includes support of cave research in northern Mexico and annual *The Death Coral Caver* newsletter. Contact Peter Sprouse or Susie Lasko at 512-873-0256.)

Texas Cave Management Association

P.O. Box 202853
Austin, TX 78720-2853

(Cave gating and cleanup projects, volunteer mobilization. Manages Amazing Maze, O-9 Well, Whirlpool, Lost Oasis, and Marigold caves. Contact Mike Warton, 512-250-0705.)

Texas Nature Conservancy

Hill Country Bioreserve
T. James Fries, Director
P.O. Box 164255
Austin, TX 78716-4255
512-327-9472

(Manages Ezell's Cave, Eckert James River Bat Cave, supports research.)

Texas System of Natural Laboratories, Inc.

Navenna Travis, Director
P.O. Box 1644
Austin, TX 78767-1644
512-417-4925

(Manages karst preserves for Tooth, Kretschmarr, Gallifer, and other caves near Austin.)

Barton Springs/Edwards Aquifer

Conservation District
1124A Regal Row
Austin, TX 78748
512-282-8441

Bill Couch, Director; Ronald G. Fieseler,
Environmental Planning Technician

(Promotes groundwater conservation and recharge enhancement, manages Antioch Cave in Onion Creek, sponsors karst watershed research and cave cleanup projects.)

Bat Conservation International

500 N Capital of Texas Highway
Austin, TX 78746
512-327-9721

(\$25 annual membership, magazine, conservation projects, manages Bracken Bat Cave.)

Texas Parks and Wildlife Department

4200 Smith School Road
Austin, TX 78744

Contact Robert Burnett, 512-444-1127, regarding cave access and management in State parks. (Manages Devil's Sinkhole as a bat preserve and other caves as ecological/scientific/educational preserves.)

U. S. Fish and Wildlife Service

Austin Area Office
Sam Hamilton, Director
611 East 6th Street
Austin, TX 78701
512-482-5436

(Enforces U.S. Endangered Species Act and supports karst research.)

Texas Cavers' Reunion

300 Mockingbird
Austin, TX 78745

(Hosts the reunion each October. Contact Gill Ediger at 512-441-0050.)

Aggie Speleological Society

(Meets 2nd and 4th Wednesday of the month at 8:30 pm in Francis Hall, Texas A&M. Contact Alan Glennon, 409-847-0873).

Bexar Grotto

(Meets 2nd and 4th Mondays of each month at 7:30 pm, at Chester's Hamburger Company, 16609 San Pedro, San Antonio. Contact Joe Ivy or Linda Palit, 210-699-1388).

DFW Grotto

(Meets 4th Wednesday of each month at 7:00 pm at Ramada Hotel Market Center at 3232 W. Mockingbird, Dallas. Contact Barbe Barker, 817-481-7933).

Galveston Grotto

Don Williams
6315 Central City Road
Galveston, Texas 77551

Greater Houston Grotto

(Meets the 3rd Tuesday of each month at Red Cross Building, 2700 SW Freeway, Houston. Contact Bob Booth 713-861-8663, or Carol McGee 713-449-4842).

Lubbock Grotto

P.O. Box 1094
Lubbock, TX 79408

(Meets 1st Monday of each month at 506 Ave. G at 7:30 pm. Contact Noble Stidham, 806-763-8606).

Maverick Grotto

(Meets 2nd Tuesday of each month at 7:00 pm at Smokey's Ribs, 5300 E. Lancaster, Fort Worth. Contact Mike Anderson, 817-448-9764.).

North Texas Speleological Association

(Meets the 1st Tuesday of each month at 7:00 pm at the Polynesian Garden at Kemp St. and Kell Expressway, Wichita Falls. P.O. Box 462, Wichita Falls, TX 76307. Contact Bill Stephens 817-692-2840.)

Permian Basin Speleological Society

(Meets every 2nd Tuesday of each month at Murray's Delicatessen, 3211 W. Wadley, Midland. Food at 6:30 pm, meeting at 7:00 pm. Contact Don Carlton, 915-687-4352).

Southwest Texas Cave Club

400 Bethke Road
San Marcos, TX 78666
(Meets every other Tuesday at 7:30 pm. Contact Bruce Johnson, 512-353-2673).

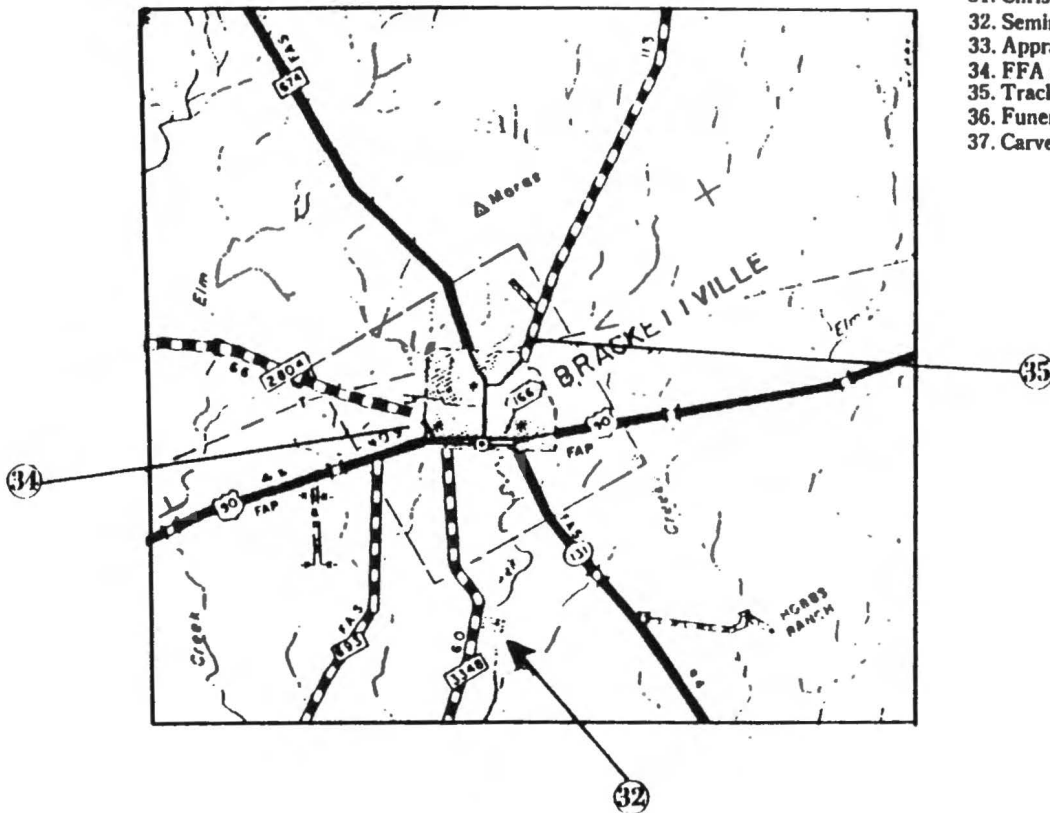
U. T. Student Grotto (University Speleological Society)

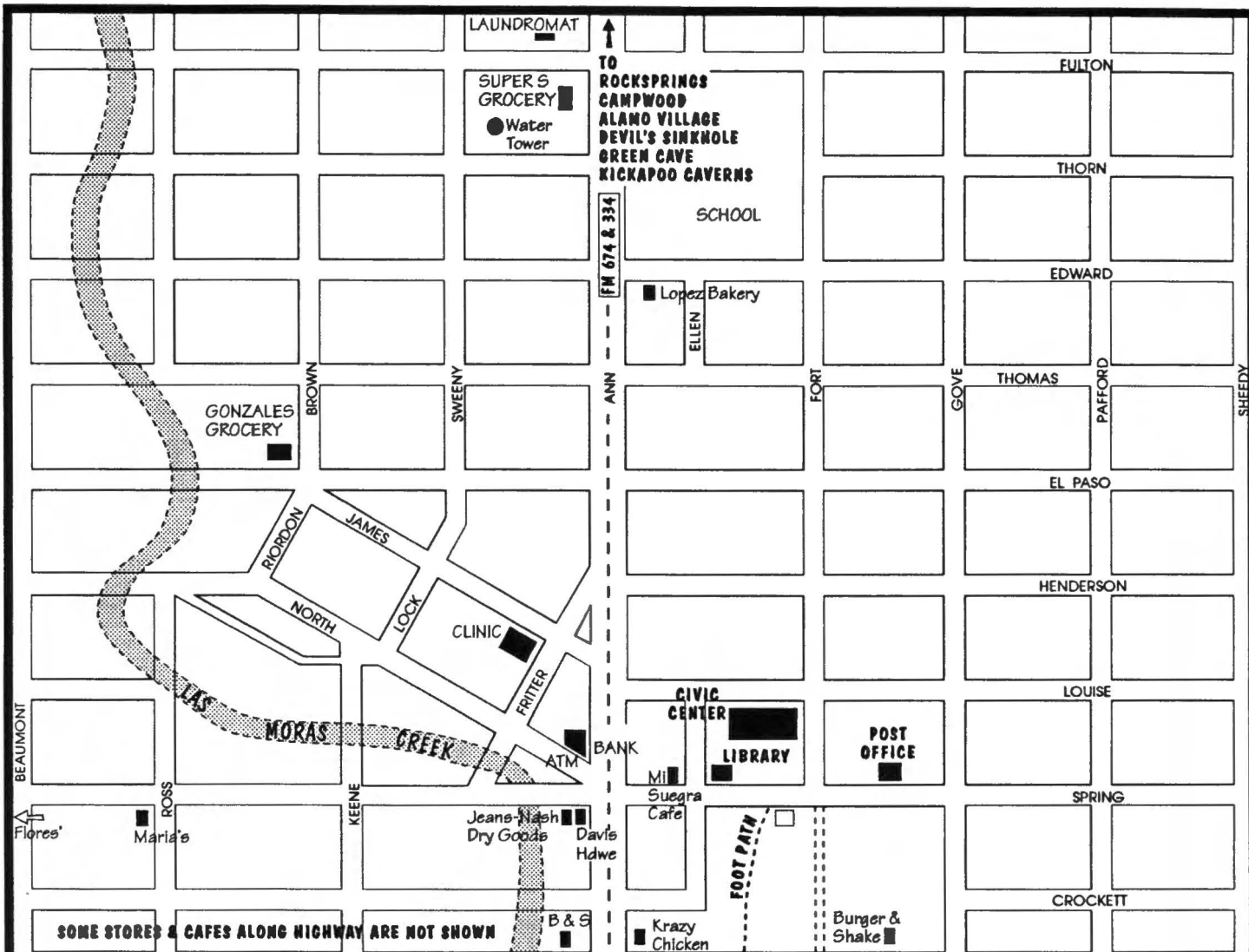
(Meets 1st, 3rd, and 5th Wednesday of each month at 7:30 pm in room 2.48, Painter Hall, The University of Texas at Austin. Contact Bill Russell, 512-453-4774 h, 512-462-7856 w).

**Brackettville is the County Seat of Kinney County
Brackettville population is 1706 and growing**

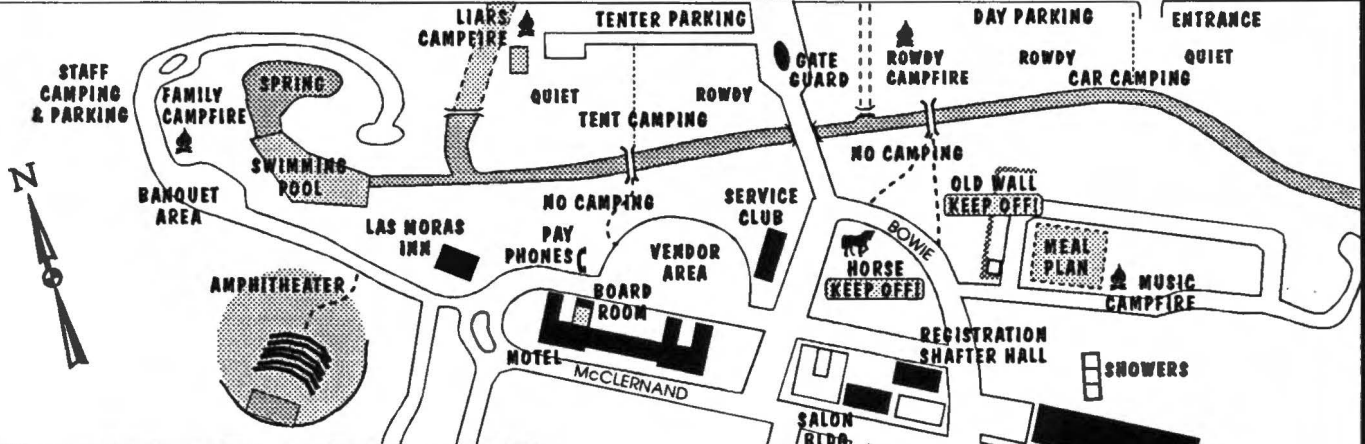
1. Post Office
2. Civic Center
3. Library
4. Courthouse Annex
5. Newspaper
6. Bank
7. Jail & Sheriff's Department
8. City Hall & Fire Station
9. Kinney County Court House
10. Clinic
11. Methodist Church
12. Catholic Church
13. Frontier Baptist Church
14. Episcopal Church
15. City Swimming Pool & Tennis Courts
16. Little League Field
17. Jerusalem Temple
18. Ballantyne Cemetery
19. Brackett Schools
20. First Baptist Church
21. School Stadium
22. Church of Christ
23. Cemeteries
24. Rio Grande Electric Co-op
25. Fritter Baseball Field
26. St. John's Baptist Church
27. Border Patrol Station
28. Kinney County Aging Services
29. Filippone Building
(Future Museum)
30. Kinney County Park
31. Christopher Columbus City Park
32. Seminole Cemetery
33. Appraisal District
34. FFA Arena
35. Track Field
36. Funeral Home
37. Carver School (Headstart)

Map provided by the
Kinney County Chamber of Commerce
Brackettville, Texas





← TO DEL RIO **90** MAIN ENTRANCE TO SAN ANTONIO →



★ **DOWNTOWN BRACKETTVILLE** ★
AND
FORT CLARK SPRINGS

PREPARED BY GILL EDIGER FOR THE
1994 CONVENTION OF THE
NATIONAL SPELEOLOGICAL SOCIETY

SCALE:
ANY AMOUNT = A SHORT DISTANCE