Program & Field Trip Guide

DEEP KARST 2016

Origins, Resources, and Management of Hypogene Karst

11-14, April 2016
Carlsbad, New Mexico USA

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Dr. George Veni, Executive Director

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Cover Photo:

Solutional spongework near the Big Room of Carlsbad Cavern, New Mexico

Because of its distinctive shape, this feature is known as the Boneyard. It was formed by the simultaneous enlargement of many interconnected pores, which were primary features in the Capitan Reef. This process is usually attributed to dissolution by slow-moving phreatic water. In the Guadalupe Mountains, however, it is more likely that they were formed above the water table by condensation of H_2S-rich water vapor in zones of air movement, to form acidic water films on the limestone surfaces. Absorption of both H_2S and O_2 from the cave air kept the water film acidified so that all surfaces could dissolve simultaneously at rather similar rates. These features are most common in the interface zones between larger parts of the caves, where air was (and often still is) moving between one large area and another. The void density and sizes are influenced by the configuration of initial pores, the gas concentrations, and the rate and direction of air flow. Photo and description by Art Palmer.

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WELCOME LETTERS

National Cave and Karst Research Institute

9 January 2016

Welcome Cave and Karst Scientists, Managers, and Explorers to DeepKarst 2016!

This is the National Cave and Karst Research Institute's (NCKRI) first conference focused on hypogene karst. NCKRI Headquarters, where DeepKarst will be held, is located in Carlsbad, New Mexico. The karst of this region's Guadalupe Mountains and Permian basin is one of the major type areas where the geologic puzzles that grew into hypogene theory first developed.

Hypogene development of karst aquifers is now a well-recognized phenomenon internationally. Appropriately, this conference includes papers from around the world, examining topics ranging from hypogene theory to hypogene fauna, and from hypogene hazards to hypogene resources.

But this meeting is more than just a meeting of like minds. For the science to grow and understanding to flourish, we have encouraged papers that challenge us to better define and recognize hypogene features and settings. We have scheduled two field trips and a diverse array of optional trips where we can discuss and perhaps debate hypogene phenomena in both carbonate and evaporite terrains. The trips will be led by people who are not just the most knowledgeable about the karst of the local area, but nationally prominent karst geologists.

This conference is sponsored by the International Union of Speleology (UIS) and co-organized with the UIS Commission on Karst Hydrogeology and Speleogenesis. On behalf of everyone at NCKRI, I thank them and especially the members of the DeepKarst 2016 Organizing Committee for their generous support.

Sincerely,

George Veni, Ph.D.
DeepKarst 2016 Chairman
NCKRI Executive Director
UIS Vice President of Administration

UNION INTERNATIONALE DE SPELEOLOGIE
UNION INTERNATIONAL OF SPELEOLOGY
Commission d'Hydrogéologie karstique et de Spéléogenèse
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On behalf of the UIS Commission on Karst Hydrogeology and Speleogenesis, it is my great pleasure to welcome the organizers and all attendees of the DeepKarst-2016, the conference dedicated to origins, resources, and management of Hypogene Karst.

For many decades, one of the cornerstones of the karst paradigm was a notion that karst development is ultimately related to the surface exposure, and is controlled by the erosional base level. Solution features found in deep-burial environments were commonly viewed as paleokarst, resulting from karstification in exposed settings in the past. Ideas that karst can develop at depth without direct genetic relationship to the surface have a long history, but remained on the periphery of karstological thinking, not influencing the traditional paradigm of karst until the last 25 years.

A burst in hypogene karst studies during the last decade resulted in that the notion of hypogene karst has changed from an aberrant curious phenomenon to one of the fundamental categories of karst, at least of equal importance with more familiar epigene karst. This surge is changing the whole karst science, making it more closely linked with many mainstream geological disciplines. It opens new vast research areas but it also raises many new challenging questions. Studying hypogene karst requires understanding of much deeper and broader geological, geodynamic and hydrogeological contexts, and in far-reaching retrospective.

An advanced understanding of hypogene karst holds a promise to decisively contribute to solving of many problems in exploration of petroleum, ore and geothermal resources associated with soluble formations. Importantly, the role of hypogene karstification lays not only in enhancing reservoir properties, but also in improving potential for the vertical fluid migration across heterogeneous strata. Thus, hypogene karstification plays a dual role; - it creates pathways for migration of hydrocarbons and metalliferous fluids to places of their subsequent accumulation but it also contributes to the loss of the deposits by compromising the seal integrity. The latter aspect of hypogene karst has important implications also for environmental assessments related to exploration of unconventional oil and gas resources and geological sequestration of CO_2. Needless to say, the recognition of specific characteristics of hypogene karst is crucial for assessment and mitigation of environmental/engineering hazards, including sinkhole formation, groundwater inrushes to mines, etc.

For this rapidly evolving topic, thematic conferences such as DeepKarst-2016 play a particularly important role, stimulating and shaping further researches. Therefore, the UIS Commission on Karst Hydrogeology and Speleogenesis was happy to closely cooperate with

NCKRI in organizing the DeepKarst-2016 Conference in Carlsbad, NM – the capital of one of the world's most renowned regions of hypogene karst.

I am sure that the Symposium will greatly enrich experience of every attendee and result in a significant advancement in our understanding of hypogene karstification/speleogenesis. I wish to all a pleasant time and productive work at this conference in Carlsbad.

Dr. *Alexander Klimchouk*
President of the Commission on Karst Hydrogeology and Speleogenesis
of the Union International of Speleology
Leading Scientist of the Institute of Geological Sciences,
National Academy of Sciences of Ukraine, Kiev, Ukraine

SCHEDULE AT-A-GLANCE

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CONFERENCE SCHEDULE

Overview and General Notes

The conference is comprised of seven (7) days of activities: 2 days of technical sessions, 2 days of conference field trips, and 3 days of optional field trips. Full details of each day's activities can be found in the Conference Schedule below.

A summary is provided here to assist the participants in finding full descriptions of all conference activities, which are provided by date in the Conference Schedule.

Technical Sessions

There are 7 technical sessions: six (6) contain oral presentations, and one contains poster presentations.

Monday, 11 April 2016

T1. Hypogenic Speleogenesis Models
T2. Poster Session
T3. Regional Case Studies in Hypogenic Speleogenesis

Tuesday, 12 April 2016

T4. Hypogenic Speleogenesis and Petroleum
T5. Hydrothermal Karst
T6. Hypogenic Drivers for Ecosystems
T7. Local Case Studies in Speleogenesis

A full listing of the technical sessions and the presentations within them are listed by date below. Breaks are built into the schedule each day, both between and within technical sessions, and are listed in the schedule.

Conference Field Trips

There are two conference field trips. Both are full-day trips. Lunches and transportation are provided to all conference participants. No caving gear is required for either.

All conference participants will tour the hypogene karst of the Pecos Valley Region in New Mexico in Field Trip #1 led by Lewis Land on Wednesday, 13 April. Then, on Thursday, 14 April, conference participants will tour Carlsbad Cavern in Field Trip #2. Trip leaders will be George Veni and Lewis Land. More information for both trips can be found on pages 27 and 28.

Important Information Regarding Lower Cave, Carlsbad Cavern

All conference participants will have four different opportunities to visit the lower level of Carlsbad Cavern, known as Lower Cave, if they so choose. During Conference Field Trip #2, participants will have the option to forgo either the upper or lower tourist portion of Carlsbad Cavern and instead tour Lower Cave. This opportunity will be led by Lewis Land. Those choosing to visit Lower Cave in the morning will miss the upper part of the tourist trail and those visiting Lower Cave in the afternoon will miss the lower part of the tourist trail.

In addition, an optional field trip to Lower Cave will be offered twice: 10 April and 15 April. The optional field trip will cover many of the same passages as Field Trip #2 on Thursday, 14 April. However, the optional field trip will include a longer route, more detailed discussions, and will be led by different cave scientist than the leaders for Field Trip #2. For more details about Lower Cave, see pages 29-30.

Meals

All conference participants will be provided with lunches on the days of Technical Sessions and Conference field trips. In addition, all conference participants are invited to a reception on the evening of 11 April, the Conference banquet on the evening of 12 April, and a dinner on the evening of 14 April during the field trip. More details are provided in each day's listing in the Conference Schedule below, and the locations are shown on the map on page 22.

Optional Field Trips

The optional field trips are designed to give participants an opportunity to visit area caves that illustrate the major features of hypogenic speleogenesis. Leading each field trip will be a cave scientist who has done a great deal of detailed research in that particular cave. This will enable the participants to examine and discuss the cave and its features in detail and with a knowledgeable expert's insight. Participants may sign up for these field trips in advance or during the conference.

Leaders for each of the optional trips will be designated from the following list: Stan Allison, Paul Burger Dave Decker, Harvey DuChene, Jim Goodbar, Art Palmer, Peggy Palmer, Paula Provencio, Victor Polyak, Michael Queen, and Kevin Stafford

Conference participants will have the opportunity to participate in up to three (3) optional field trips of the seven (7) offered. Caving equipment is necessary for each of these trips, and participants must provide their own in compliance with restrictions dictated by White-nose Syndrome regulations. Information on required gear has been provided on the Conference website in advance of the Conference and is also available here on page 47.

The list of optional field trips and dates offered are provided here. Full details are provided in this Program beginning on page 29.

NAME OF OPTIONAL FIELD TRIP	DATES OFFERED		
	SUN 10 APRIL	FRI 15 APRIL	SAT 16 APRIL
Coffee Cave	X	X	X
Cottonwood Cave		X	X
Dry Cave	X		X
Left Hand Tunnel, Carlsbad Cavern	X		
Lower Cave, Carlsbad Cavern	X	X	
Ogle Cave		X	
Slaughter Canyon Cave		X	
Spider Cave			X

Sunday, 10 April 2016

Please see the descriptions for the following Optional Field Trips that will be offered this day:

- Coffee Cave (pages 39-40)
- Dry Cave (pages 41-42)
- Left Hand Tunnel, Carlsbad Cavern (pages 31-32)
- Lower Cave, Carlsbad Cavern (pages 29-30)

Monday, 11 April 2016

8 to 8:20 am **Welcoming Remarks**

8:20 to 9 am **Keynote Lecture: Brief History of the Hypogene Speleogenesis Model, Guadalupe Caves, New Mexico, USA**
Carol Hill, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, USA

9 to 9:20 am **Break**

T1. Hypogenic Speleogenesis Models

Paper #	Time	
1-1	9:20 am	**SULFURIC ACID VS. EPIGENIC CARBONIC ACID IN CAVE ORIGIN AND MORPHOLOGY** Palmer, Arthur N. *Dept. of Earth and Atmospheric Sciences, State University of New York, Oneonta, NY 13820-4015, USA, arthur.palmer@oneonta.edu*
1-2	9:40 am	**A RE-EVALUATION OF HYPOGENIC SPELEOGENESIS: DEFINITION AND CHARACTERISTICS** Veni, George *National Cave and Karst Research Institute, 400-1 Cascades Avenue, Carlsbad, New Mexico 88220, USA, gveni@nckri.org*
	10:00 am	**Break**
1-3	10:20 am	**A SUPERCRITICAL CO_2 HYPOGENIC SPELEOGENESIS MODEL: THE ORIGIN OF SPAR CAVES AND CAVE SPAR IN THE GUADALUPE MOUNTAINS, USA** Decker, David D.[1], Polyak, Victor J.[2], and Asmerom, Yemane[3] *[1] University of New Mexico, Radiogenic Isotopes Lab, Department of Earth & Planetary Sciences, MSC003-2040, Albuquerque, NM 87131-0001* *[2] University of New Mexico, Radiogenic Isotopes Lab, Department of Earth & Planetary Sciences, MSC003-2040, Albuquerque, NM 87131-0001* *[3] University of New Mexico, Radiogenic Isotopes Lab, Department of Earth & Planetary Sciences, MSC003-2040, Albuquerque, NM 87131-0001*
1-4	10:40 am	**CLIMATE, SEA LEVEL CHANGES AND DEEP KARST** Zhang, Shouyue[1], and Jin, Yuzhang[2] *[1] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, China, syzhangjin822@163.com* *[2] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, China*

T2. Poster Session

Paper #	On Display	
2-1	11 am-12 pm	**MORPHOMETRIC ANALYSIS OF LIMESTONE HYPOGENE CAVES IN THE WESTERN UNITED STATES** Kambesis, Patricia[1], and Despain, Joel D.[2] *[1] Department of Geography and Geology, Western Kentucky University, Bowling Green, Kentucky* *[2] Mendocino National Forest, Willows, California*
2-2	11 am-12 pm	**IBERGER TROPFSTEINHÖHLE, IBERG, HARZ MOUNTAINS, GERMANY: HYPOGENE MORPHOLOGY AND ORIGIN BY SIDERITE WEATHERING** Kempe, Stephan[1], Bauer, Ingo[2], and Krause, Ortrud[3] *[1] Institute for Applied Geosciences, Technische Universität Darmstadt* *Schnittspahnstr. 9 D-64287 Darmstadt, Germany,* *kempe@geo.tu-darmstadt.de* *[2] Institute for Applied Geosciences, Technische Universität Darmstadt Schnittspahnstr. 9 D-64287 Darmstadt, Germany,* *bauer@geo.tu-darmstadt.de* *[3] HöhlenErlebnisZentrum Iberger Tropfsteinhöhle An der Tropfsteinhöhle 1 (B 242) D-37539 Bad Grund (Harz), Germany* *ortrud.krause@hoehlen-erlebnis-zentrum.de*
2-3	11 am-12 pm	**NEW DEVELOPMENTS IN THE SCIENCE OF HYPOGENE CAVES IN NSW, AUSTRALIA** Osborne, Robert Armstrong *Education & Social Work, A35 The University of Sydney, NSW 2006, Australia armstrong.osborne@sydney.edu.au*
2-4	11 am-12 pm	**TYPES OF HYPOGENIC SPELEOGENESIS** Klimchouk, Alexander *Institute of Geological Sciences of the National Academy of Sciences of Ukraine 55-bGonchara Street, Kiev, Ukraine, 01054,* *klim@speleogenesis.info*

Noon Catered Lunch

T3. Regional Case Studies in Hypogenic Speleogenesis

Paper #	Time	
3-1	1:40 pm	**SULFURIC ACID CAVES OF ITALY: AN OVERVIEW** D'Angeli, Illenia Maria[1], De Waele, Jo[2], Galdenzi, Sandro[3], Madonia, Giuliana[4], Parise, Mario[5], Piccini, Leonardo[6], and Vattano, Marco[7] *[1] Department of Biological, Geological and Environmental Sciences Via Zamboni 67 40126 Bologna, Italy, ilenia.dangeli@alice.it* *[2] Department of Biological, Geological and Environmental Sciences Via Zamboni 67 40126 Bologna, Italy, jo.dewaele@unibo.it* *[3] Viale Verdi, 10 Jesi, Italy, galdenzi.sandro@tiscali.it* *[4] Department of Earth and Marine Sciences Via Archirafi 22 90123 Palermo, Italy, giuliana.madonia@unipa.it* *[5] National Research Council, IRPI Via Amendola 122-I 70126 Bari, Italy, m.parise@ba.irpi.cnr.it* *[6] Department of Earth Sciences Via La Pira 4 50121, Firenze, Italy, leonardo.piccini@unifi.it* *[7] Department of Earth and Marine Sciences Via Archirafi 22 90123 Palermo, Italy, marco.vattano@unipa.it*
3-2	2:00 pm	**VARIOUS SETTINGS FOR THE DEVELOPMENT OF HYPOGENIC CAVES AND PALEOKARST FEATURES IN THE ARBUCKLE MOUNTAINS, OKLAHOMA, USA** Blackwood, Kevin W. *East Central University, 1100 E 14th Street Ada, OK, 74820, USA, kevwbla@ecok.edu or karstgeoscience@gmail.com*
	2:20 pm	**Break**
3-3	2:40 pm	**EVIDENCE OF HYPOGENIC KARST DEVELOPMENT IN THE TAURUS MOUNTAIN RANGE, TURKEY** Bayari, Serdar C.[1], Ozyurt, Nur N.[2], Klimchouk, Alexander[3], Törk, Koray[4], and Nazik, Lütfi[5] *[1] Hacettepe University, Dept. of Geological Eng. Beytepe Campus, Ankara, 06800, Turkey, serdar@hacettepe.edu.tr* *[2] Hacettepe University, Dept. of Geological Eng. Beytepe Campus, Ankara, 06800, Turkey, nozyurt@hacettepe.edu.tr* *[3] Institute of Geological Sciences Natl. Academy of Science of Ukraine 55-b Gonchara Str., Kiev 01054 Ukraine, klim@speleogenesis.info* *[4] Karst and Cave Research Unit General Directorate of Mineral Research and Exploration Dumlupınar Bulvarı 139, Ankara, 06800 Ankara, Turkey, cave@mta.gov.tr* *[5] Ahi Evran University, Dept. of Geography Sahir Kurutluoğlu Cad. 100, Kırşehir, 40100, Turkey, lutfinazik@ahievran.edu.tr*

3-4 3:00 pm **THE INFLUENCE OF SYNDEPOSITIONAL FAULTING AND BRECCIA ZONES ON HYPOGENE CAVE DEVELOPMENT AND MORPHOLOGY IN THE GUADALUPE MOUNTAINS, NEW MEXICO**

Burger, Paul A.
National Park Service 240 W 5th Avenue Anchorage, AK, 99501, USA, paul_burger@nps.gov

3:40 pm **Break**

3-6 4:00 pm **HYPOGENIC MORPHOLOGIES AND SPELETHEMS IN CAVES OF THE MURCIA REGIÓN, SOUTH-EASTERN SPAIN**

Gázquez, Fernando[1], Calaforra, José María[2], Ros, Andrés[3], Llamusí, José L.[4], and Sánchez, Juan[5]
[1] Department of Earth Sciences, University of Cambridge Downing Street, Cambridge, CB2 3EQ, United Kingdom. f.gazquez@ual.es
[2] Department of Biology and Geology. University of Almeria, Carretera de Sacramente s.n, La Cañada de San Urbano, Almería, 04720, Spain. jmcalaforra@ual.es
[3] Centre for Natural and Marine Environmental Studies. CENM-naturaleza Alcántara, 5, Cartagena, Murcia, 30394, Spain. cenm@cenm.es
[4] Centre for Natural and Marine Environmental Studies. CENM-naturaleza Alcántara, 5, Cartagena, Murcia, 30394, Spain. cenm@cenm.es
[5] Centre for Natural and Marine Environmental Studies. CENM-naturaleza Alcántara, 5, Cartagena, Murcia, 30394, Spain. cenm@cenm.es

3-7 4:20 pm **DEEP PHREATIC INFLUENCE ON THE ORIGIN OF CAVES AND KARST IN THE CENTRAL APPALACHIAN GREAT VALLEY**

Doctor, Daniel H.[1], and Orndorff, Wil[2]
[1] U.S. Geological Survey, 12201 Sunrise Valley Drive, MS926A, Reston, Virginia, 20191, dhdoctor@usgs.gov
[2] Virginia Dept. of Conservation and Recreation, Natural Heritage Program, 8 Radford Street, Christiansburg, VA 24073, Wil.Orndorff@dcr.virginia.gov

7 – 9 pm **All conference participants are cordially invited to a reception on the second floor of the Lucky Bull Grill at the corner of Canal and Fox streets (see map on page 22).**

Tuesday, 12 April 2016

8 to 8:20 am **Announcements**

T4. Hypogenic Speleogenesis and Petroleum

Paper #	Time	
4-1	8:20 am	**HYPOGENE KARST ASSOCIATED WITH PETROLEUM RESOURCES IN PECOS COUNTY, TEXAS** Stafford, Kevin W.[1], and Faulkner, Melinda S.[2] *[1] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, staffordk@sfasu.edu* *[2] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, mgshaw@sfasu.edu*
4-2	8:40 am	**THE POTENTIAL ROLE OF HYPOGENIC SPELEOGENESIS IN THE LOWER FLORIDAN AQUIFER AND SUNNILAND OIL TREND, SOUTH FLORIDA, U.S.A.** Herbert, Thomas A.[1], and Upchurch, Sam B.[2] *[1] Lampl Herbert Consultants, Inc. P.O. Box 10129 Tallahassee, Florida 32302-2129, taherbert@lampl-herbert.com* *[2] SDII Global Corporation 4509 George Road Tampa, Florida 33634, flwaterdoc@gmail.com*
4-3	9:00 am	**ENGINEERING GEOHAZARDS IN HYPOGENE EVAPORITE KARST: CASTILE FORMATION, WEST TEXAS** Stafford, Kevin W.[1], and Faulkner, Melinda S.[2] *[1] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, staffordk@sfasu.edu* *[2] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, mgshaw@sfasu.edu*

9:20 to 9:40 am **Break**

T5. Hydrothermal Karst

Paper #	Time	
5-1	9:40 am	**DISCUSSION ON THE PROCESS OF DEEP KARST AND HYDROTHERMAL KARST** Lu, Yaoru[1], Liu, Qi[2], and Zhang, Wei[3] *[1] Department of Geotechnical Engineering, Tongji University* *[2] Department of Geotechnical Engineering, Tongji University* *[3] Institute of Hydrogeology and Environmental Geology, Chinese Academy of Geological Sciences*
5-2	10:00 am	**HERCULES AND DIANA HYPOGENE CAVES (HERCULANE SPA, ROMANIA): DISSIMILAR CHEMICAL EVOLUTIONS EXPERIENCED BY THEIR PRESENT-DAY THERMAL WATER DISCHARGES** Mitrofan, Horia[1], Marin, Constantin[2], Povara, Ioan[3], and Onac, Bogdan P.[4] *[1] "Sabba Ştefănescu" Institute of Geodynamics of the Romanian Academy, 19-21 Jean-Louis Calderon Street, 020032 Bucharest, Romania, oria.mitrofan@geodin.ro* *[2], constmarin@gmail.com* *[3] "Emil Racoviţă" Institute of Speleology of the Romanian Academy, Calea 13 Septembrie 13, 050711 Bucharest, Romania, ipov.iser@gmail.com* *[4] School of Geosceinces, University of South Florida, 4202 E. Fowler Ave., NES 107, Tampa, FL 33620 USA & "Emil Racoviţă" Institute of Speleology of the Romanian Academy, Clinicilor 5, 400006 Cluj, Romania, bonac@usf.edu*
5-3	10:20 am	**ENVIRONMENTAL EFFECT OF KARST GEOTHERMAL RESOURCES WITH RATIONAL UTILIZATION IN NORTH CHINA PLAIN** Zhang, Wei[1], Wang, Guiling[2], and Liu, Feng[3] *[1] No.268, Zhonghua North Street, Xinhua District Shijiazhuang City, Hebei Province, 050061, China, zhangwei1306@126.com* *[2] No.268, Zhonghua North Street, Xinhua District Shijiazhuang City, Hebei Province, 050061, China, guilingw@163.com* *[3] No.268, Zhonghua North Street, Xinhua District Shijiazhuang City, Hebei Province, 050061, China, 542507283@qq.com*
10:40 to 11 am		**Break**

T6. Hypogenic Drivers for Ecosystems

Paper #	Time	
6-1	11:00 am	**BIOTIC CHANGES IN A DEEP SULFIDIC OFFSHORE SINKHOLE** Rubelmann, III, Haydn[1] and Garey, James R.[2] *[1] University of South Florida 4202 E. Fowler Ave. SCA 110 Tampa, FL, 33620, U.S.A. rubelman@mail.usf.edu* *[2] University of South Florida 4202 E. Fowler Ave. ISA 2015 Tampa, FL, 33620, U.S.A. garey@usf.edu*
6-2	11:20 am	**CHEMOAUTOTROPHICALLY BASED SUBTERRANEAN ECOSYSTEMS** Sarbu, Servan M. *"Emil Racoviţă" Institute of Speleology of the Romanian Academy, Calea 13 Septembrie 13, 050711 Bucharest, Romania, iserbansarbu@yahoo.com*
6-3	11:40 am	**MESIC VEGETATION COMMUNITIES WITHIN THE OWL CREEK AND BEAR CREEK WATERSHEDS AS EVIDENCE OF UPWARD MIGRATION OF DEEP-SEATED KARST** Faulkner, Melinda S.[1] and Stafford, Kevin W.[2] *[1] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, mgshaw@sfasu.edu* *[2] Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, staffordk@sfasu.edu*
	Noon	**Catered Lunch**

T7. Local Case Studies in Speleogenesis

Paper #	Time	
7-1	2:00 pm	**THE COMPLEX EVOLUTIONARY HISTORY OF HYPOGENE KARST SYSTEMS: AN EXAMPLE FROM THE GIANT MAZES OF NE BRAZIL** Auler, Agusto S.[1], Klimchouk, Alexander[2], Bezerra, Francisco H.R.[3], Cazarin, Caroline L.[4], and Balsamo, Fabrizio[5] *[1] Instituto do Carste Rua Aquiles Lobo 297 Belo Horizonte, MG, 30150-160, Brazil, aauler@gmail.com* *[2] National Academy of Sciences 55-b Gonchara Str. Kiev, 01054, Ukraine, klim@speleogenesis.info* *[3] Departamento de Geologia Universidade Federal do Rio Grande do Norte Natal, RN, 59078-970, Brazil, bezerrafh@geologia.ufrn.br* *[4] Centro de Pesquisa e Desenvolvimento Leopoldo A. Miguez de Mello Petrobras Rio de Janeiro, RJ, 21941-915, Brazil, cazarin@petrobras.com.br* *[5] Dipartimento di Fisica e Scienze della Terra "Macedonio Melloni" Università degli Studi di Parma Parco Area delle Scienze 157/A Parma, I-43124, Italy, fabrizio.balsamo@unipr.it*

7-2 2:20 pm **CONDENSATION CORROSION SPELEOGENESIS IN THE AMARGOSA DESERT AND THE TECOPA BASIN**

Dublyansky, Yuri[1], Klenke, John[2], and Spötl, Christoph[3]
[1] *Institute of Geology, Innsbruck University Innrain 52 Innsbruck, 6020, Austria, juri.dublyansky@uibk.ac.at*
[2] *Nye County Nuclear Waste Repository Project Office 2101 E. Calvada Blvd. Ste., 100 Pahrump, NV 89048, USA, jklenke@co.nye.nv.us*
[3] *Institute of Geology, Innsbruck University Innrain 52 Innsbruck, 6020, Austria, christoph.spoetl@uibk.ac.at*

2:40 pm **Break**

7-3 3:00 pm **ACTIVE HYPOGENIC CAVE IN ITALY**

Galdenzi, Sandro[1], and Menichetti, Marco[2]
[1] *Viale Verdi, 10, Jesi, 60035, Italy Galdenzi.sandro@tiscali.it*
[2] *University of Urbino Pure and Applied Sciences Department, Campus Scientifico Urbino, 61029, Italy, marco.menichetti@uniurb.it*

7-4 3:20 pm **HYPOGENE IMPRINTS IN COASTAL KARST CAVES FROM MALLORCA ISLAND (WESTERN MEDITERRANEAN): A REVIEW OF THE CURRENT KNOWLEDGE ON THEIR MORPHOLOGICAL FEATURES AND SPELEOGENESIS**

Ginés, Joaquín[1], Fornós, Joan J.[2], Gràcia, Francesc[3], Merino, Antoni[4], Onac, Bogdan P.[5], and Ginés, Angel[6]
[1] *Federació Balear d'Espeleologia C/ Uruguai s/n. Palma Arena 07010 Palma de Mallorca, Illes Balears, Spain, jginesgracia@yahoo.es*
[2] *Grup de Geologia i Paleontologia, Dept. Biologia, Universitat de les Illes Balears Ctra. de Valldemossa km 7.5 07122 Palma de Mallorca, Illes Balears, Spain, joan.fornos@uib.es*
[3] *Federació Balear d'Espeleologia C/ Uruguai s/n. Palma Arena 07010 Palma de Mallorca, Illes Balears, Spain, xescgracia@yahoo.es*
[4] *Federació Balear d'Espeleologia C/ Uruguai s/n. Palma Arena 07010 Palma de Mallorca, Illes Balears, Spain, tonymerinoj@gmail.com*
[5] *School of Geosciences, University of South Florida 4202 E. Fowler Ave., NES 107 Tampa, FL 33620 USA, bonac@usf.edu*
[6] *Federació Balear d'Espeleologia C/ Uruguai s/n. Palma Arena 07010 Palma de Mallorca, Illes Balears, Spain, agines.gracia@yahoo.es*

3:40 pm **Break**

7-5 4:00 pm **STRUCTURAL CONTROL OF RELICT HYPOGENE KARST FEATURES IN THE OWL MOUNTAIN PROVINCE, FORT HOOD MILITARY INSTALLATION, TEXAS**

Faulkner, Melinda S.[1] and Stafford, Kevin W.[2]
[1] *Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, mgshaw@sfasu.edu*
[2] *Stephen F. Austin State University, Department of Geology P.O. Box 13011, SFA Station, Nacogdoches, TX 75962, staffordk@sfasu.edu*

7-6 4:20 pm **HYPOGENE CAVE MORPHOLOGY AT HIGH RESOLUTION: FULL-3D SURVEY OF MÄRCHENHÖHLE (AUSTRIA)**

Dublyansky, Yuri[1], Roncat, Andreas[2], Spötl, Christoph[3], and Dorninher, Peter[4]
[1] *Institute of Geology, Innsbruck University Innrain 52 Innsbruck, 6020, Austria, juri.dublyansky@uibk.ac.at*
[2] *Institute of Photogrammetry and Remote Sensing, Vienna University of Technology Gußhausstraße 27-29/E120 Vienna, 1040, Austria, ar@ipf.tuwien.ac.at*
[3] *Institute of Geology, Innsbruck University Innrain 52 Innsbruck, 6020, Austria, christoph.spoetl@uibk.ac.at*
[4] *Institute of Photogrammetry and Remote Sensing, Vienna University of Technology Gußhausstraße 27-29/E120 Vienna, 1040, Austria, pdo@ipf.tuwien.ac.at*

7-7 4:40 pm **CAVE INCEPTION IN DEDOLOMITE (A CASE STUDY FROM CENTRAL SLOVENIA)**

Otoničar, Bojan[1]
[1] *Karst Research Institute SRC SASA , Titov trg 2 SI-6230 Postojna, Slovenia, otonicar@zrc-sazu.si*

6:30 to 9:30 pm **All conference participants are invited to the banquet at the Stevens Inn on Canal Street (see map on page 22).**

Barbara J. Tewksbury, Professor of Geosciences at Hamilton College in Clinton, New York (USA), will deliver the banquet lecture entitled, *Is Hypogene Karst a Plausible Model for Formation of Extensively Developed Non-Tectonic Synclines in Eocene Limestone of the Western Desert, Egypt?*

Wednesday, 13 April 2016

Title	**FIELD TRIP #1: HYPOGENE KARST OF THE PECOS VALLEY REGION**
Leader	Lewis Land, karst hydrogeologist with the New Mexico Bureau of Geology and Mineral Resources and the National Cave and Karst Research Institute
Description	A one-day tour of the karstic geomorphology and hydrology of the Pecos Valley region in southeastern New Mexico. Points of interest will include karst springs, sinkholes, subsidence basins, and outcrops illustrating regional stratigraphic relationships that control artesian flow systems on both local and regional scales. This field trip is for all conference participants.

Evening **To give conference participants the opportunity to socialize and relax outside of the formal conference setting, dinner this evening is on your own.**

Thursday, 14 April 2016

Title	**FIELD TRIP #2: HYPOGENE CAVE MORPHOLOGIES IN CARLSBAD CAVERN**
Leaders	George Veni, karst hydrogeologist and Executive Director of the National Cave and Karst Research Institute Lewis Land, karst hydrogeologist with the New Mexico Bureau of Geology and Mineral Resources and the National Cave and Karst Research Institute
Description	Carlsbad Cavern contains the largest rooms by volume in the Americas and is a World Heritage Site. Passages extend to over 1,000 feet deep with mapped passage length at approximately 30 miles. It is considered by many as one of the type localities of hypogenic cave development. The tour will visit the main part of the cave on a tour that extends from the Natural Entrance through the Main Corridor and the Big Room. Optionally, two groups, one in the morning and one in the afternoon, will have the choice to visit Lower Cave* instead of portions of the main cave along the paved tourist trail. Those visiting Lower Cave in the morning will miss the area from the Natural Entrance to the Big Room. Those visiting Lower Cave in the afternoon will miss the Big Room. This field trip is for all conference participants.

6 to 9 pm **Dinner at Camp Washington Ranch is part of the field trip. All conference participants will be transported there from Carlsbad Cavern.**

Friday, 15 April 2016

Please see the descriptions for the following Optional Field Trips that will be offered this day:

- Coffee Cave (pages 39-40)
- Cottonwood Cave (pages 43-44)
- Lower Cave, Carlsbad Cavern (pages 29-30)
- Ogle Cave (pages 37-38)
- Slaughter Canyon Cave (pages 35-36)

Saturday, 16 April 2016

Please see the descriptions for the following Optional Field Trips that will be offered this day:

- Coffee Cave (pages 39-40)
- Cottonwood Cave (pages 43-44)
- Dry Cave (pages 41-42)
- Spider Cave (pages 33-34)

LOCATION AND VENUE

Carlsbad is a small but friendly community in southeastern New Mexico, with a population of about 30,000 people. The town was founded in the late 1800s by ranchers from west Texas, along a reach of the Pecos River where flow is supplied in part by karst springs in the bed of the river.

The major industries in Carlsbad include tourism, potash mining (southeastern New Mexico contains the United States' largest known concentration of potash reserves), oil and gas production, agriculture, and activities associated with the Waste Isolation Pilot Plant (WIPP), a disposal facility for defense-related transuranic radioactive waste.

The city was established around the hypogenically-formed karstic Carlsbad Spring. Carlsbad is an oasis in the desert with its tree-lined streets, numerous public parks and recreation areas, and municipal beach and greenway along Lake Carlsbad next to the conference venue.

Parks

Among people interested in caves and karst, "Carlsbad" is synonymous with "Carlsbad Caverns National Park," located only 30 minutes by car to the southwest along Highway 62/180. Another 30 minutes farther and into Texas, is the Guadalupe Mountains National Park.

These parks offer world-class views of middle Permian geology and hypogenic karst. Highway 62/180 traverses a striking and unique gypsum karst terrain that includes Parks Ranch Cave, the second-longest gypsum cave in the United States.

The discovery of the "Bat Cave," near the end of the 19th Century, led to the establishment of Carlsbad Caverns National Park on May 14, 1930. As a result, the City of Carlsbad gained international recognition.

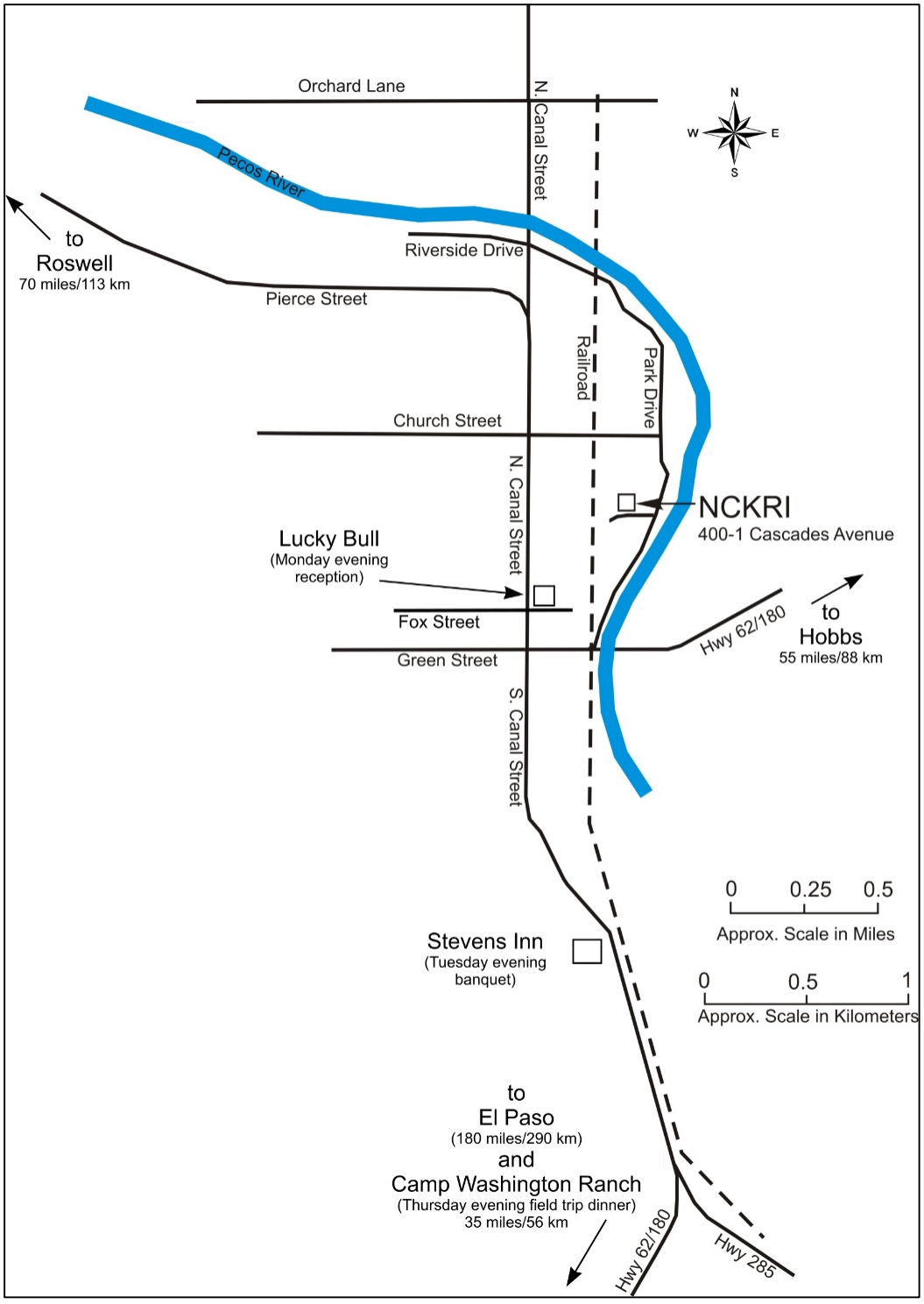
Museums

In downtown Carlsbad is the Carlsbad Museum and Art Center, which has an interesting exhibit on the region's history and often hosts excellent special or traveling exhibits. At the city's north end is the Living Desert State Park and Zoo, a beautifully developed display of flora and fauna of the desert southwest region of the U.S.

About an hour's drive farther north, and especially if you fly in via Roswell, is the International UFO Museum and Research Center. A visit to the IUMRC is always entertaining.

Climate

During the time of the conference, daytime high temperatures are likely to range between 70-80°F (21-27°C) with overnight lows of about 50°F (10°C). Rain is unlikely, but expect possible strong winds.


Orchard Lane
N. Canal Street
N
W
E
S
Pecos River
to
Roswell
70 miles/113 km
Riverside Drive
Pierce Street
Railroad
Park Drive
Church Street
N. Canal Street
NCKRI
400-1 Cascades Avenue
Lucky Bull
(Monday evening
reception)
Fox Street
Green Street
Hwy 62/180
to
Hobbs
55 miles/88 km
S. Canal Street
0 0.25 0.5
Approx. Scale in Miles
Stevens Inn
(Tuesday evening
banquet)
0 0.5 1
Approx. Scale in Kilometers
to
El Paso
(180 miles/290 km)
and
Camp Washington Ranch
(Thursday evening field trip dinner)
35 miles/56 km
Hwy 62/180
Hwy 285

KEYNOTE LECTURE

BRIEF HISTORY OF THE HYPOGENE SPELEOGENESIS MODEL, GUADALUPE CAVES, NEW MEXICO, USA

Carol A. Hill

Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, USA

Internationally renowned cave mineralogist and geologist Carol Hill will trace her early involvement with the caves of the Guadalupe Mountains since 1967, specifically with respect to their hypogene speleogenetic origin. The Guadalupe Mountains form the physical backdrop of this DeepKarst conference and will be the focus of most conference field trips. Their study started with the Guadalupe Cave Survey—a group of cavers who were given permission to survey in Carlsbad Cavern in the late 1960s. This group provided the organization and interfacing with the National Park Service that was needed before scientific studies could begin in Carlsbad Cavern and then branch out to other Guadalupe-area caves under federal land management.

Carol's lecture will highlight the ongoing (in time) contributions of scientists/cavers such as Steven Egemeier, Donald Davis, Michael Queen, Carol Hill, Harvey DuChene, Dave Jagnow, Victor Polyak, Diana Northup, Penny Boston, Doug Kirkland, and Art and Peg Palmer, all of whose work has been based on, and has contributed to, the ever-developing model of hypogene speleogenesis. This model has now been applied to many other parts of the world, including the caves of Grand Canyon—possibly the deepest hypogene karst system in the world.

Carol Hill began caving in 1963 (NSS #8449) in the Flint-Mammoth Cave System, Kentucky. In 1967 she moved with her husband Alan and sons Larry and Roy to New Mexico and immediately began caving with New Mexico cavers in the Guadalupe Mountains. In 1971, as a graduate student in geology at the University of New Mexico, she began actively working on the mineralogy of Carlsbad Cavern, but in 1979 changed her focus to the sulfuric acid speleogenesis of Guadalupe caves based on her sulfur isotope analyses of cave gypsum.

The sum of this early work was incorporated into her book *Geology of Carlsbad Cavern and Other Caves in the Guadalupe Mountains* in 1987, eventually culminating in her more regional study of the *Geology of the Guadalupe Mountains* in 1996. She has published three editions of *Cave Minerals*: in 1976, 1986, and the most recent *Cave Minerals of the World* in 1997 with co-author Paolo Forti. Since that time (for the last 17 years) she has been working with University of New Mexico colleague Victor Polyak on the caves and evolution of Grand Canyon, with articles published in *Science*, *Geomorphology*, *Journal of Hydrology*, and *Geosphere*. Carol is presently an Adjunct Professor in the Department of Earth and Planetary Sciences at the University of New Mexico.

BANQUET LECTURE

IS HYPOGENE KARST A PLAUSIBLE MODEL FOR FORMATION OF EXTENSIVELY DEVELOPED NON-TECTONIC SYNCLINES IN EOCENE LIMESTONE OF THE WESTERN DESERT, EGYPT?

Barbara J. Tewksbury

Department of Geosciences, Hamilton College, Clinton, New York, USA

To paraphrase Sherlock Holmes, when you have eliminated the impossible, whatever remains, however improbable, might be the truth. Everyone loves a mystery, and Dr. Barbara Tewksbury has a lovely one. In limestones of Egypt's Western Desert, she has discovered a network of synclines that are developed over tens of thousands of square kilometers. At first you'd think they are tectonic, but you'd be wrong. They are sag structures, but what caused the sag? So, what about hypogene karst? While these synclines are developed over a truly enormous area, what she and her co-workers currently know about the network is better explained by hypogene speleogenesis than by any other model considered to date. You are invited to help solve the mystery, see why other mechanisms have been rejected, and suggest if hypogene processes may be the solution or if there are other possibilities to consider.

Barbara Tewksbury is Professor of Geosciences at Hamilton College, where she has been on the faculty for over 35 years and currently holds the Upson Chair. She is a structural geologist, and her most recent research has been in Iceland and Egypt. She is lead PI on the NSF-funded Desert Eyes Project to study the nature and origin of enigmatic bedrock structures in the Western Desert of Egypt. For the past six years, she has also been one of a small number of classroom and field instructors for NASA astronaut geology training and has also been part of NASA analog field studies for human planetary surface exploration. Tewksbury has played a leadership role in the national geoscience education community for over 15 years and has given dozens of workshops to faculty in departments across the country and abroad. She is co-PI on the decade-long NSF-funded project *On the Cutting Edge*, a national professional development program to improve undergraduate geoscience education. Tewksbury is a past

president of the American Geosciences Institute and the National Association of Geoscience Teachers. She was named New York State Professor of the Year in 1997 by the Carnegie Foundation for the Advancement of Teaching and was the 2004 recipient of Neil Miner Award for exceptional contributions to the stimulation of interest in the Earth Sciences from the National Association of Geoscience Teachers (NAGT). http://people.hamilton.edu/btewksbu

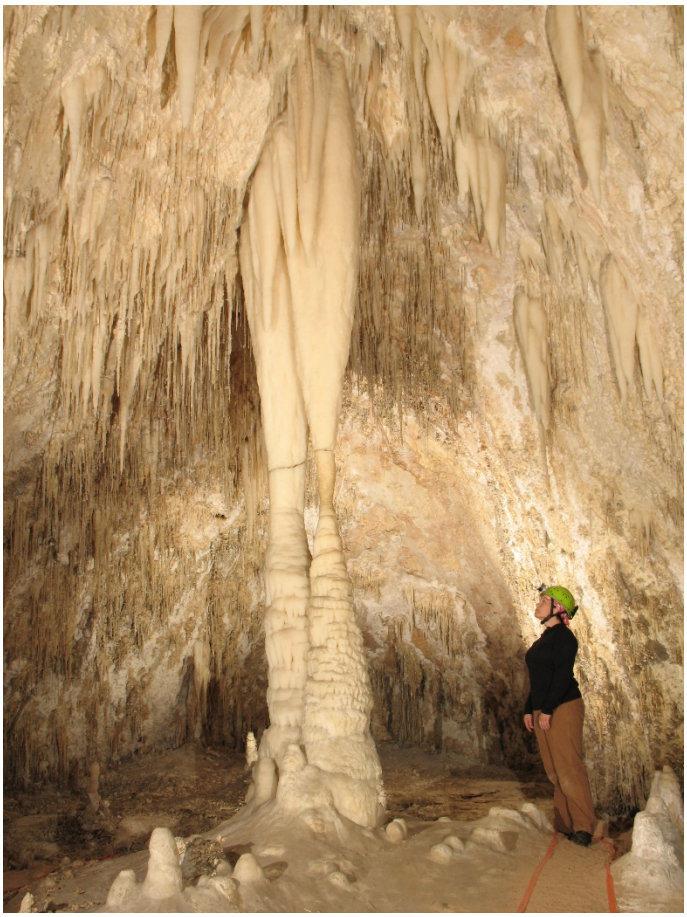
GUIDE TO THE CONFERENCE FIELD TRIPS

Trip #1 Wednesday: Hypogene Karst of the Pecos Valley Region

The Wednesday field trip for DeepKarst 2016 will involve a one-day tour of the karstic geomorphology and hydrology of the Pecos Valley region in southeastern New Mexico. Communities in this area rely to a large extent on hypogenic water resources stored in karstic artesian aquifers such as the San Andres limestone and the Capitan Reef. The trip will include visits to a local spring discharging from the Capitan Reef aquifer, a subsidence basin associated with subsurface dissolution of evaporites; a former reservoir that was abandoned because of leakage through sinkholes in the lake bed, and several road cuts that illustrate carbonate-evaporite facies relationships in the Guadalupe Mountains region. The trip will conclude at Bottomless Lakes State Park, where large gypsum cenotes discharge groundwater from a regional karstic artesian aquifer underlying the city of Roswell, New Mexico.

Trip #2 Thursday: Hypogene Cave Morphologies in Carlsbad Cavern

Carlsbad Cavern is the largest show cave in the Americas and a World Heritage Site. It is considered by many as one of the type localities of hypogene cave development. By attending this trip, you will see primary sedimentary structures, world-class speleothems, passages, and chambers, secondary gypsum, and classic hypogene karst morphologies.



This field trip will be provided in three parts:

1) Morning trip along the paved from the Natural Entrance down to the Big Room.

2) Afternoon trip along the paved trail around the Big Room.

3) Off-trail trip to the Lower Cave area of the cavern; one trip for 12 people will be offered in the morning and a second trip for 12 more people will be offered in the afternoon.

You can participate in two of the three parts. If you join either Lower Cave trip, you will not participate in the part of the trip along the paved trail scheduled for that time. Also, notice that optional trips are offered to Lower Cave on April 10th and 15th. You can find more details about Lower Cave on pages 29-30.

The exact times for the parts of this trip are not known at this time. The elevators to the Big Room are currently out of service. It is not known if they will be repaired in time for these trips, thus the exact trip times will be announced during the conference.

DeepKarst Conference

National Cave and Karst Research Institute, Carlsbad, NM

April 10, 15, 16, 2016

Cave maps have been greatly simplified for this guide. These are merely to help determine which field trips are of interest to you.

Lower levels of Carlsbad Cavern (half day)

Carlsbad Caverns National Park is located about a 40-minute drive southwest from the NCKRI conference center on Rte. 62 / 180. On Thursday April 14, 2006, the entire Conference group will visit the main part of the cave on a tour that extends from the natural entrance through the Main Corridor and the Big Room, with an exit via elevator up to the Visitor Center.

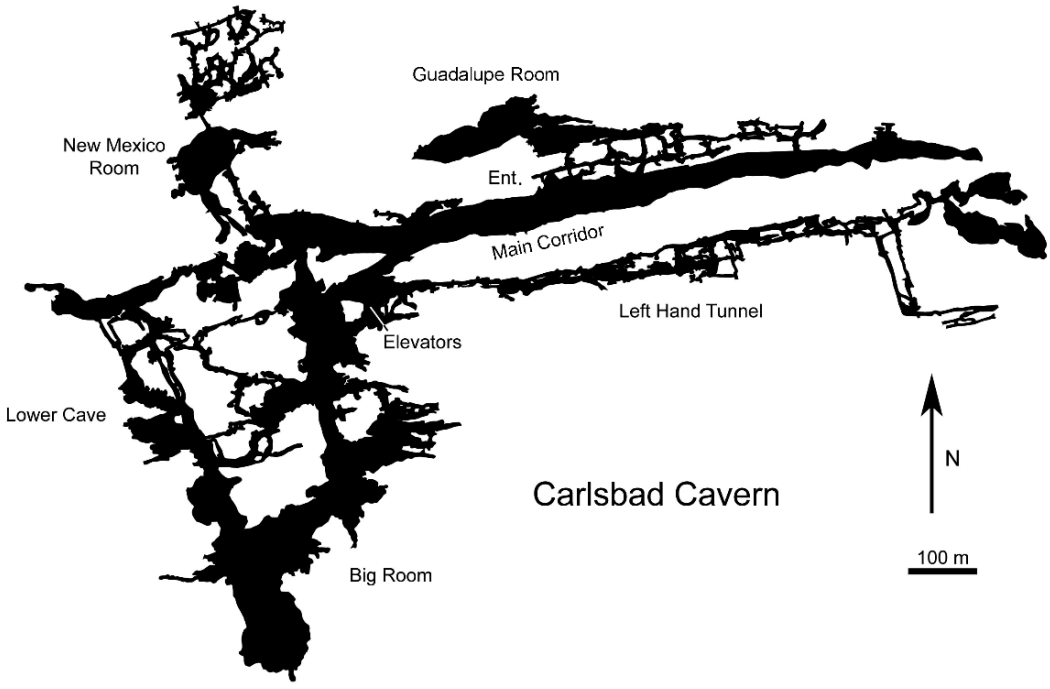


Fig. 1: Map of Carlsbad Cavern, simplified from surveys by Cave Research Foundation.

The cave is developed mainly in the massive limestone of the Capitan Reef, which forms the southeastern escarpment of the Guadalupe Mountains that overlooks the evaporative strata of the Delaware Basin.

The optional visit to the “Lower Cave” lasts about 3 hrs and includes large irregular rooms and smaller connecting passages. There is no fixed lighting. **Required equipment includes a helmet, lights, and sturdy boots. Cameras are welcome as long as they do not interfere with the normal tours.** Travel is mainly easy walking, interrupted by minor scrambles up and down. We enter via elevator from the Visitor Center, follow the Big Room tour backward a short distance and climb down a few short metal ladders. The route extends beneath the Big Room and into the large western passages shown on the cave map. At one point there is a spectacular view 30 m upward to a balcony on the Big Room tour.

Features of geologic interest include dripstone speleothems, many of which have been modified by condensation corrosion. Local clay deposits have been altered by sulfuric acid to the mineral alunite during the last phases of cave origin. The alunite byproduct has been used to date the various cave levels in the Guadalupe Mountains. Here the youngest alunite date is 3.9 Ma. Unusual minerals such as halloysite, thenardite, and metatyuyamunite are also present in sparse quantities and reflect the complex environmental conditions during the last phases of cave origin. Corrosion features, weathering phenomena, replacement of carbonate rock by gypsum, and a variety of speleothems are visible at close range.

Gravel and sand deposits in one area show evidence for late-stage stream invasion from the surface. Near the western end of the cave is Nicholson Pit, a narrow irregular shaft that once carried rising water and H_2S into the cave. Nearby a large upper level is visible that was contemporaneous with the Big Room level of cave development.

Fig. 2: “Lower Cave” of Carlsbad Cavern, located about 25 m below the Big Room level. (Photos by A.N. Palmer, except where noted otherwise.)

Left Hand Tunnel, Carlsbad Cavern (half day)

The location is shown on the map on the previous page. The Left Hand Tunnel is reached via elevators in the Visitor Center. Much of this route is also visited by the public on special tours using lantern light. We will avoid interfering with this tour so that our lights do not disrupt them. There are no fixed artificial lights.

Our trip will last about 2 hours. **A helmet, lights, and sturdy shoes are required.** Cameras are welcome. Also note the requirement for minor vertical equipment described below in **bold type** if the plans include a traverse across a rift beyond the normal tour trail.

Fig. 2: "Lower Cave" of Carlsbad Cavern, located about 25 m below the Big Room level. (Photos by A.N. Palmer, except where noted otherwise.)

We pass through the Lunch Room, where souvenirs and minor food items are on sale. The floor of the Left Hand Tunnel lies at the same level as the floor of the Big Room. This represents one of the major stages of cave development in the region. The Left Hand Tunnel consists of a series of high fissure-like passages interconnected to form local network patterns. In places the floor drops into rifts as much as 20 m deep, some of them traversed by bridges. These appear to have been routes by which the original H_2S gas rose in solution. There are scattered pools surrounded by evaporative mineral deposits (aragonite, huntite, hydromagnesite, dolomite, etc.), which form irregular shapes that contrast with the more typical stalactites and stalagmites, which are also abundant in the passage. In some areas there is evidence for corrosion by condensation of water vapor carried by persistent winds.

Beyond the normal tourist route is a traverse over a deep fissure that must be bypassed with the aid of a short (3 m) ascent, traverse of about 10 m, and descent on the other side. **Appropriate vertical gear includes a seat sling, two carabiners on "cow's tails" and a descender.** The traverse requires minimal vertical skills, but the equipment described here

is still needed for safety. The Left Hand Tunnel extends to several major passage complexes at various levels. One descends steeply to the deepest point in the cave, Lake of the Clouds, which unfortunately is not accessible at this time of year to avoid disturbing a bat colony. Instead we will visit a complex fissure network that shows a variety of unusual speleothem types.

Depending on interest and coordination with the National Park Service, trips to the New Mexico Room and Guadalupe Room may also be offered (see Fig. 1).

Fig. 4: Pool and speleothems in Left Hand Tunnel.

Spider Cave, Carlsbad Caverns National Park (half day)

From the Visitor Center, Spider Cave is a 5 minute drive on an unpaved road, plus a 20 minute walk into a shallow canyon. The cave trip lasts about 2–4 hrs, depending on the interest of the group. Required equipment includes **abrasion-resistant clothing, helmet, lights, kneepads, gloves, and perhaps some food**. Cameras are welcome but should be protected in a dust-proof container or pack. There are no spiders in the cave!

The entrance passage is a low crawlway about 10-15 m long and about 30 cm high. It looks tight but is really rather easy. The National Park Service periodically runs tours through here with no trouble. The main part of the cave is a complex maze in the back-reef Yates Formation, which consists of silty dolomitic limestone. It has been intensely weathered to a variety of red, yellow, gray, and white in complex patterns, with soft, crumbly textures.

The cave is mainly dry, with only a few moist and muddy places. The passages are guided by complex structures including “tepees,” which are polygonal features that resemble large mud cracks. The cave map illustrates the complexity of the cave and the structures that guide it. There is one major level with several minor levels in places that require frequent minor climbs and scrambles. A modest amount of caving skill is helpful.

There are many calcite speleothems, nearly all of which have been bleached to a ghostly white by subaerial weathering. Helictites are abundant in places and tend to grow upward from ledges. Similar features in other caves have been attributed to rising water, but here the evidence is less clear. Bedrock weathering is apparently enhanced by microbial processes to produce a coating of what are termed “speleosols.” Red-yellow silt covers much of the floor.

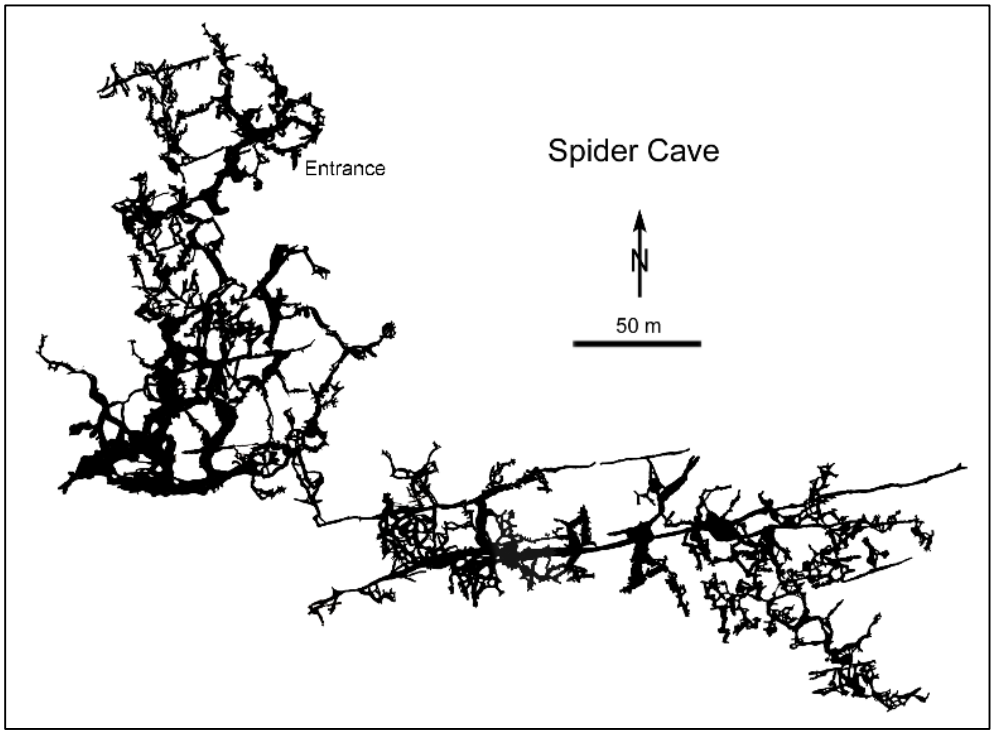


Fig. 5: Main portion of Spider Cave, simplified from map by Paul Burger, NPS.

In one area (in the vicinity of the sharp bend in the cave pattern on the map) there is a downward loop through an area of moist mud. A short climb is required, but it is easy to share assistance if needed. A deep fissure nearby is one of several suspected sources for H_2S-rich water when the cave was actively forming.

Ancient water lines appear in several places, enhanced by a faint Mn oxide coating. These appear to be the results of rare short-term flooding from the nearby canyon.

Spider Cave is almost unique in its combination of unusual features.

Fig. 6: One of the larger passages in Spider Cave. Note intense weathering of bedrock, with gray remnants of calcite wall coatings.

Slaughter Canyon Cave, Carlsbad Caverns National Park – formerly known as New Cave (half day)

A 50 minute drive down Rte. 68 - 180 from the conference center, with a 15–20 minute hike up a steep 1 km trail to the entrance. This cave is named for an early settler family; neither the cave nor the canyon has a sinister history. It is located within Carlsbad Caverns National Park and open to public tours. Our cave trip will last about 2-3 hours, depending on the amount of photography. **Sturdy shoes, good light, and helmet** are required. The cave has no artificial lighting. A field hat, sunglasses, and water are also recommended for the surface trail.

Fig. 7: Slaughter Canyon.

The cave is developed along the contact between the massive Capitan Formation and the fore-reef breccia unit. It consists of large interconnected rooms strongly oriented along parallel joints. A fixed, knotted 5 m rope provides aid on a steep descent.
Well-maintained trails extend through most of the cave. Please stay on the trails!

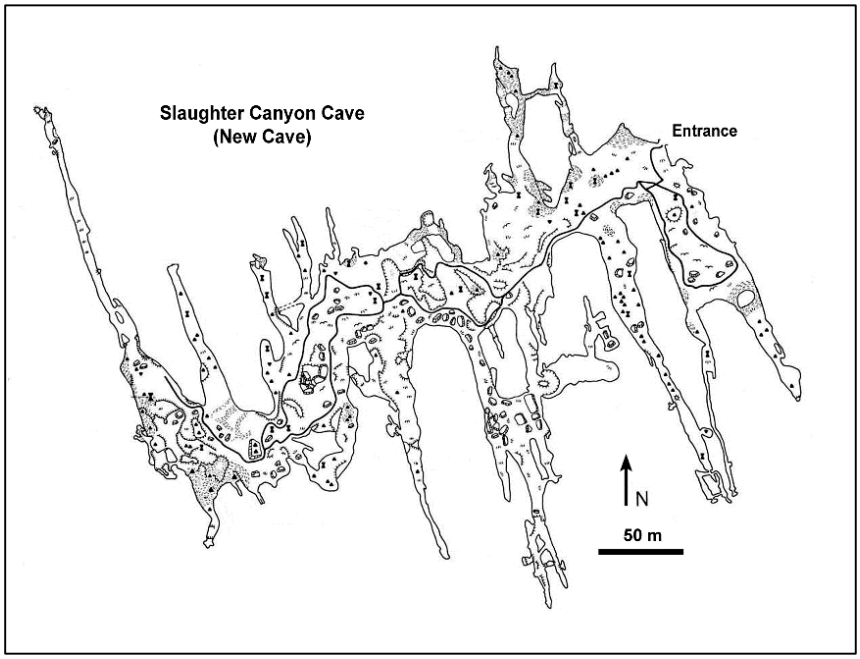


Fig. 8: Map of Slaughter Canyon Cave, simplified from original by the Cave Research Foundation.

This restriction may interfere with the desire for cross-lighting in photos, as was the case for the photo below (Fig. 9). Large and bizarre speleothems exhibit several stages of growth and modification by weathering. There are traces of former guano mining. The guano has been dated at several thousand to tens of thousands of years BP. Bats are rare in the cave today.

From the entrance of this cave, the entrance of Ogle Cave can be seen across the canyon (see next page).

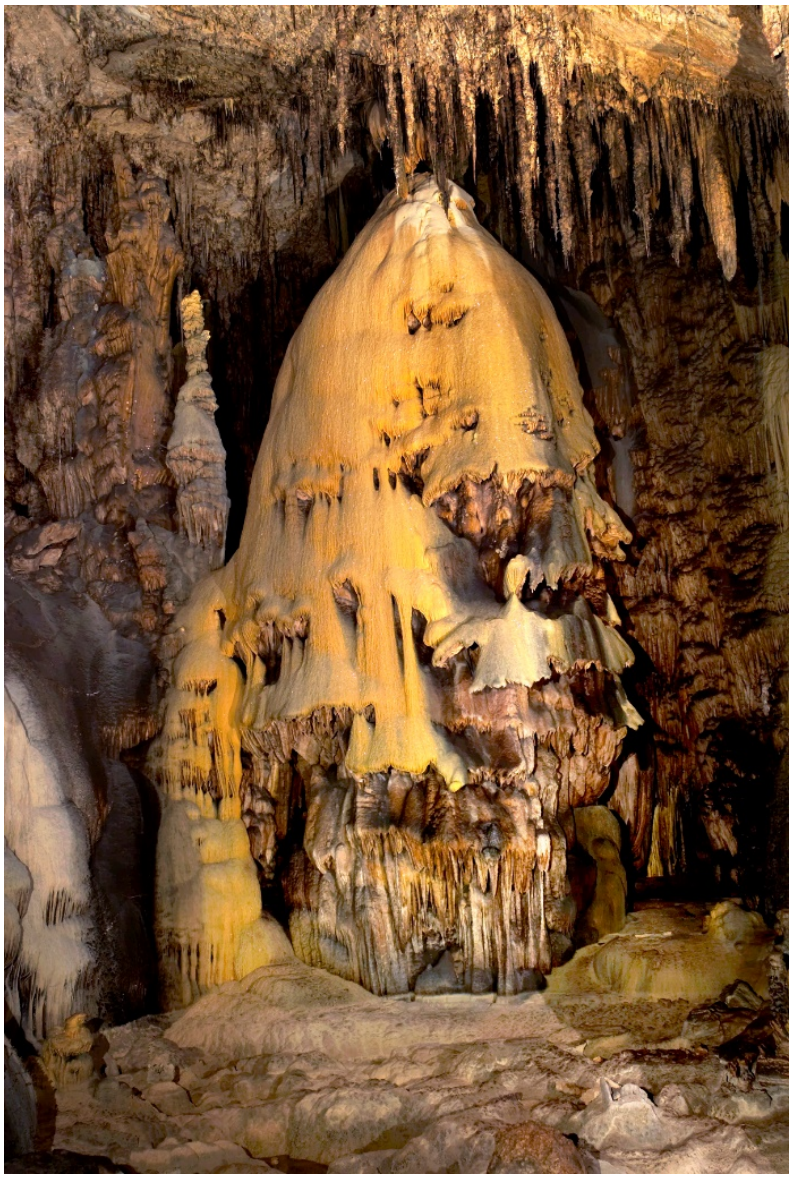


Fig. 9: One of several prominent speleothems in Slaughter Canyon Cave (about 5-7 m tall). Some are more bizarre, even frightening.

Ogle Cave, Carlsbad Caverns National Park (full day)

A 50 minute drive down Rte. 68 - 180 from the NCKRI conference center, with a 20-30 minute hike up a steep canyon wall to the main entrance. The cave trip lasts about 5 hrs, depending on the number of participants. The entrance requires a 56 m rope descent and ascent (rope provided). There are several ledges, so beware of dropping loose rocks. **Required: helmet, light, sturdy boots, gloves, full vertical gear for rope descent and ascent, and cave food.**

The cave consists mainly of a large joint-guided passage with an irregular side room, and follows roughly along the contact between the Capitan reef and the fore-reef talus member. It contains impressive dripstone speleothems up to 32 m tall, some of them unusually shaped (and one resembling the cartoon character Snoopy). Shield formations are also present. At the southern end of the cave a hole at the top of a sheer wall leads to the much-smaller Rainbow Cave (closed to recreational caving). The route through the cave is irregular, with no improved trail, but not difficult. Near the southern end of the Ogle section, note the diagonal sandstone dike, an early structural feature in the fore-reef carbonates.

Scattered remnants of equipment from former guano excavation are found in the cave and at the surface near the entrance. The miners blasted incomplete tunnels in the western room of the cave and at the surface in a failed effort to bypass the entrance drop. (Note the short linear extension on the cave map below.)

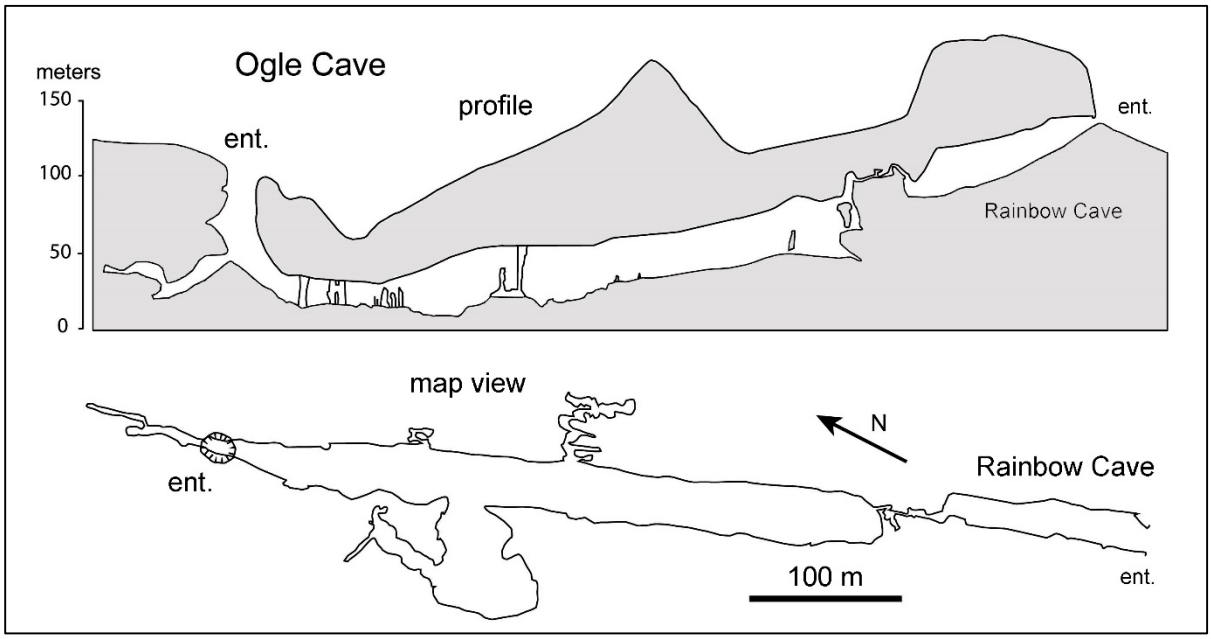


Fig. 10: Map and profile of Ogle Cave, simplified from Cave Research Foundation map of 1975.

Fig. 11: Main passage of Ogle Cave. The ceiling height exceeds 30 m in places.

Coffee Cave, gypsum plain along Pecos River (half day)

This cave is about a 20 minute drive north from the NCKRI headquarters, plus a 20 minute hike on easy horizontal trails. The cave trip itself requires about 1–2 hrs, depending on the amount of discussion. Bring **helmet and light, sturdy boots, kneepads, and gloves**.

Although many caves in the Permian gypsum of the Delaware Basin have formed by water sinking at the surface, there are perhaps just as many caves and karst features that owe their origin to rising water or convection. Bottomless Lakes, seen on the Wednesday field trip, provide an excellent example where water rises through gypsum from the underlying limestone.

Coffee Cave provides an opportunity to compare the two possible modes of cave origin. It is a small joint-controlled maze in gypsum of the Delaware Basin. The host rock is the Seven Rivers Formation, which consists mainly of limestone and dolomite in Carlsbad Caverns National Park, but here it is massive nodular gypsum. The cave consists of four tiers, the lowest and largest of which are now water-filled because of damming of the Pecos River.

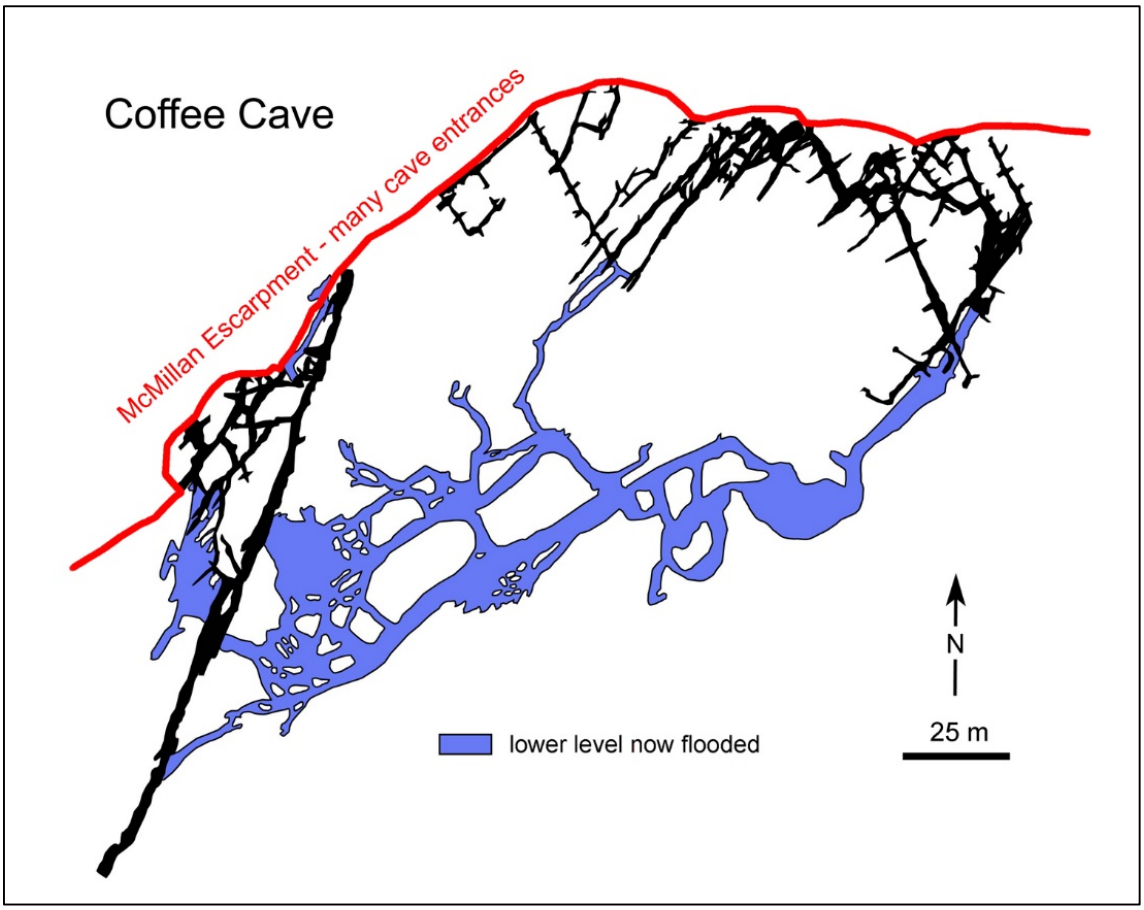


Fig. 12: Map of Coffee Cave (modified from Dave Belski (1972) and Kevin Stafford (2009).

Recent studies of the cave have revealed many features that support a hypogenic origin – a multi-level maze pattern, rise tubes and wall channels that connect levels, and outflow routes along the bedding at ceiling level. Others have attributed these same features to periodic flooding from the river, with the additional evidence of wall scallops oriented into the cave, increasing in length inward, and becoming irregular solution pockets in the cave interior. Vegetal debris from flooding is seen in many passages. Rise tubes between levels might result from condensation during summer back-flooding. So here is an excellent place to view a cave with two contrasting interpretations – hypogenic vs. floodwater dissolution – each based mainly on the same field evidence.

Fig. 13: Traverse over water-table pool in Coffee Cave. (Photo by Mark Tracy.)

Dry Cave, McKittrick Hill (full day)

This is the largest of several caves located about a 1 hour drive from the NCKRI headquarters; last half of trip is on on unimproved gravel roads. The entrance is only a few minutes from the vehicles. The cave trip will last 2–4 hours, depending on the desires of the group. Bring **helmet, lights, kneepads, gloves, and perhaps food**.

This is a very complex network maze with 19 km of mapped passages, located at the crest of a structural dome in bedded back-reef carbonates. The local strata include the Seven Rivers Formation (mainly dolomite) and the overlying Yates Formation (locally dolomite interbedded with siltstone and sandstone). Passages vary from crawlways to moderate-size rooms, with a combination of walking, stooping, scrambling, and crawling. There may be a rattlesnake or two in the entrance area, but they are shy and easily avoided.

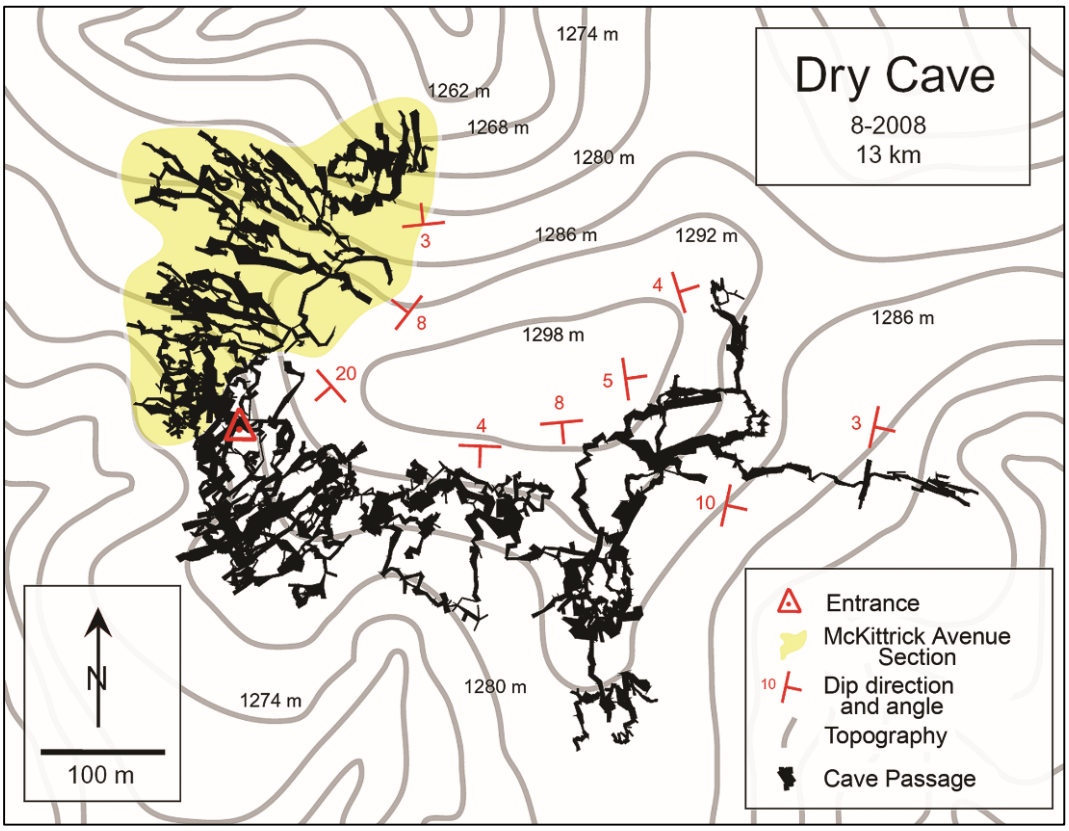


Fig. 14: Partial map of Dry Cave (after maps by Stan Allison, Aaron Stockton, et al.), showing relation of cave to the crest of a gentle structural dome in the bedded back-reef limestones.

The cave contains excellent evidence for a sulfuric acid origin, including secondary gypsum (locally replacing pisolites and other primary features in the limestone). In places, bedding planes in the bedrock can be traced laterally into the speleogenetic gypsum. Extensive weathering features and structural complexities provide variety in the passage patterns. Most of the passages are greater in width than in height. The local dip of the bedrock varies up to 20 degrees – relatively steep for this area.

The original known extent of the cave was limited to the southern flank of the anticline, but more recent discoveries have extended around the western and northwestern side (shown in yellow on the map). These extensions have inspired explorers to try to connect along the northern flank to form a continuous circle around the dome.

Alunite in nearby Endless Cave has been dated to about 4 million years, and it is likely that Dry cave has a similar age. Fossils excavated from the cave include the bones of bison, sloth, camel, wolf, and lion with dates up to 33,000 years.

Fig. 15: Hand-line traverse in Dry Cave (photo by Aaron Stockton).

Fig. 16: Secondary gypsum, a relic of sulfuric acid dissolution (photo by Gosia Allison-Kosior).

Cottonwood Cave, Lincoln National Forest (full day)

Fig. 17: Canyons and high plateaus in the western part of the Guadalupes near Cottonwood Cave.

This trip requires a drive of about 1.5 hours from NCKRI, including a steep primitive road, and about a 15-minute walk to the cave. Requirements include **helmet, light, sturdy boots, kneepads, and cave food**. Cave trips last approx. 2–6 hrs, depending on goals.

The cave is located in the high plateaus of the southwestern Guadalupes, in back-reef carbonates (Seven Rivers Formation and underlying Queen Formation). The cave opening is in the wall of a canyon with nice views of the back-reef portions of the Guadalupe Mountains. The main routes through the cave involve mainly walking through large passages in bedded back-reef carbonates.

The main passages are very large and contain some massive and unusual calcite speleothems, large gypsum crystals, and deposits of sulfur from incomplete oxidation of H_2S.

With some serious climbing and squeezing it is possible to see more variety, including the initial site where secondary gypsum from sulfuric acid dissolution of carbonates was shown to replace the internal textures of the original bedrock.

Hidden Cave (pages 45-46) is not far away. If you want to visit it on the same trip, it will be necessary to limit your time in Cottonwood.

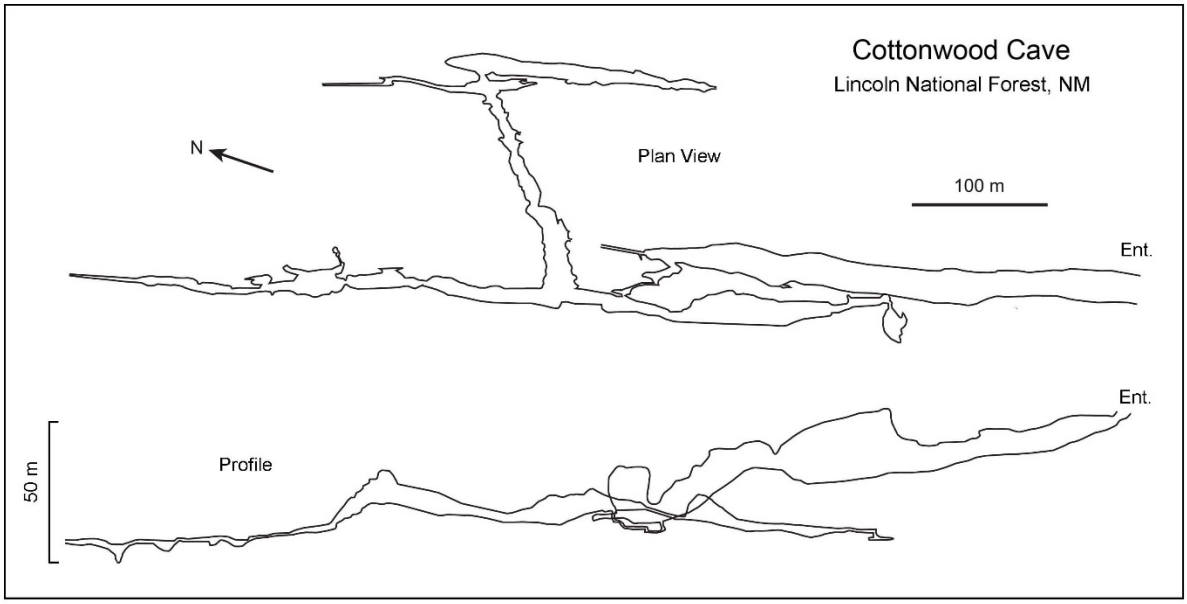


Fig. 18: Main passages in Cottonwood Cave, by Guadalupe Cave Survey (1966), simplified from detailed remapping by Dave Jagnow (1973-74).

Fig. 19: Speleothems in the main passage of Cottonwood Cave.

Hidden Cave, Lincoln National Forest (full day; may be combined with a short trip to Cottonwood Cave)

This cave is approximately a 1.75 hour drive from the NCRI conference center, including access via a steep primitive road. The walk to the cave is about 10-20 minutes, depending on how close you drive. Required equipment includes **helmet, light, gloves, sturdy boots, kneepads, and equipment for descending and ascending short ropes**. Rope drops of 12 and 7 m are required to enter the cave. Rope will be provided.

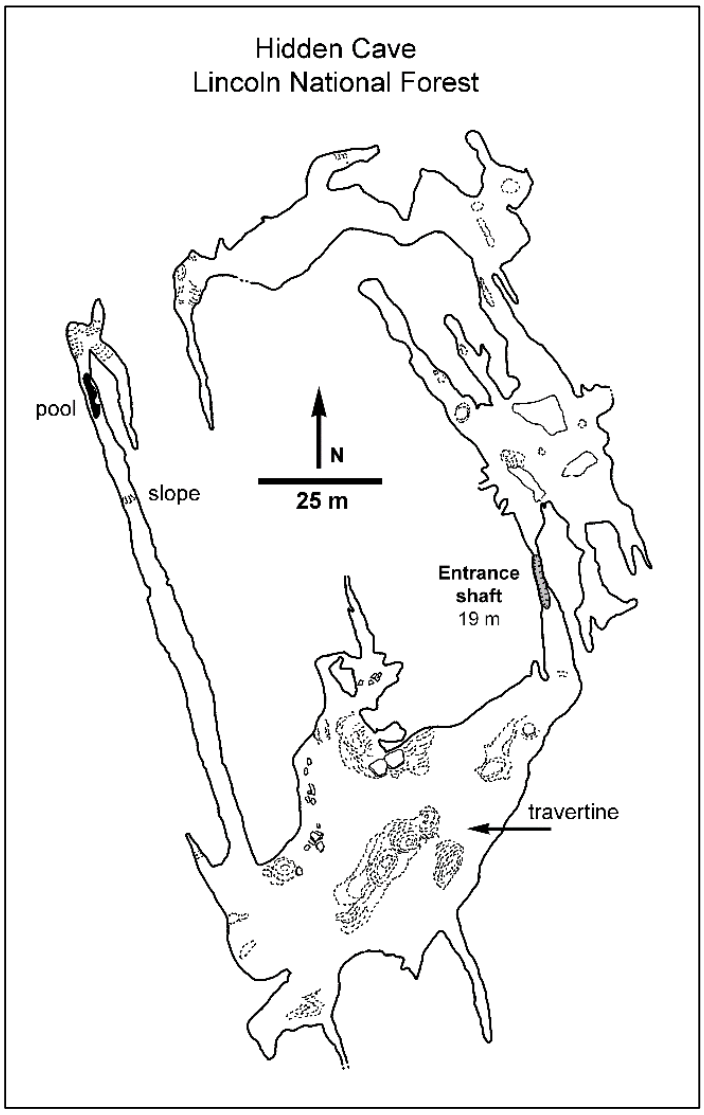


Fig. 20: Map of Hidden Cave, simplified from map by Steve Peerman.

A full cave trip, with geological and biological observations, requires about 3 hours. The cave has an irregular pattern of mainly walking-size passages with minor scrambling. Total length is about 0.75 km. Most of the floor in the cave is level to gently sloping and composed predominantly of silt and mud; long rimstone, shallow seasonal pools during wet periods. Some places are safely accessible only with a hand line (e.g., "slope" shown on the map), but they give access only to small parts of the cave. The cave is noted for its biothems (speleothems guided by, or modified by, microbial activity – see photo). Much of one's time can be spent looking at small features which tend to go unnoticed in larger caves. Most of the biothems are soft and pasty, and they are easily disturbed or damaged. Please be conservative in your examination.

Fig. 21: Biothems (cave features originating or modified by microbial action) are common in Hidden Cave. They include these examples of pasty carbonate speleothems.

There is one obvious omission from this cave list: **Lechuguilla Cave**. At this time, the National Park Service has no staff able to authorize trips there, although they are in the process of filling these positions. Information about the cave and its status will be available at the DeepKarst meeting.

IMPORTANT INFORMATION CONCERNING OPTIONAL CAVE TRIPS

1. Provide your own personal caving equipment – helmet, light, gloves, kneepads, etc. Cave temperatures are ~15–20 deg. C (~59–68 deg. F). All caves are dry except for minor pools that can be avoided.

2. Ogle Cave, Hidden Cave, and an optional part of Left Hand Tunnel in Carlsbad require equipment for rope descent and ascent (about 60 m in Ogle; about 12 m maximum in Hidden; optional short traverse in Left Hand Tunnel). Ropes will be provided: ~10 mm diameter, slightly thicker than is standard in Europe.

3. Clothing and equipment must either be new or treated for removal of microbial contaminants. The malady White-nose Syndrome is spreading throughout large areas of North America, but not yet in the Carlsbad area. This has no effect on humans but can be lethal to bats. To avoid any possible contamination, clothes and cave equipment that have been used before in caves must be treated as follows:

(1) Remove any dirt; (2) immerse in hot water at >50 deg C (122 deg F) for >20 minutes. Be sure to keep the temperature above the minimum by adding hot water periodically. Boots and other articles that would be damaged by water should instead be treated with double applications of Formula 409 “spray & wipe” cleanser, or equivalent. These steps do not need to be repeated between the trips listed here. We’re sorry for the inconvenience, but this is a federally mandated procedure – and the bats deserve every possible protection.

Clothing, footwear, or equipment that have been used in cave areas of known contamination by White-nose Syndrome must not be used on these trips.

For further details:

https://www.whitenosesyndrome.org/sites/default/files/resource/national_wns_revise_final_6.25.12.pdf

Fig. 22: El Capitan is the southern tip of the Guadalupe Mountains, a short distance south of the Texas - New Mexico border. Behind it is Guadalupe Peak, the highest point in Texas.

Surface Trails (self-guided)

Desert trails in Carlsbad Caverns National Park (~1 hour).

Take trail from Visitor Center toward main cave entrance, but turn off toward the right just before a small bridge that crosses a gulley. The trail contains a couple of loops that display desert vegetation, vistas across the gypsum plain into Texas, and former shaft entrance once used for guano mining from the Bat Cave portion of the cavern. At the far end of the parking lot to the west of the Visitor Center are some outcrops of back-reef carbonate rocks that include tepee structures. These are fractures bounded by up-turned beds, rather like the edges of large mud cracks. They have controlled many of the passage patterns in Spider Cave.

Guadalupe Mountains National Park, Texas

The best hiking and geologic exposures are seen on various trails in **Guadalupe Mountains. National Park** (immediately south of the New Mexico - Texas border on Rte. 62 / 180). Open from 8:00 18:00 (8:00 a.m to 6:00 p.m.). There is a small fee to enter Park. See **http://www.nps.gov/gumo/planyourvisit/trails.htm**. The park brochure describes the various trails.

McKittrick Canyon trail - Allow 3-5 hours to for the canyon, or all day to reach the high ridges beyond. The beginning point for this trail also provides access to other trails. The McKittrick Canyon Nature Trail displays typical topography, plants and animals of the Chihuahuan Desert. Trailside exhibits describe the most important features. The McKittrick Ridge Trail is the steepest trail in the park and covers about 25 km round trip. Excellent views of ridges and canyons. The Permian Reef Trail (15 km round trip, 600 m elevation gain) is ideal for geologists, as it offers many stops that are described in a guidebook available in the Visitor Center.

Guadalupe Peak Trail - This trail brings you to the top the highest peak in Texas, a state that is otherwise consists mainly of flat plains. The peak is at an elevation of 2667 m (8751 feet). The trail is fairly steep but well maintained, with some exposure to steep cliffs. It is rated strenuous, with about 1000 m elevation gain. The round trip distance is 14 km, and takes about 5-6 hours for those accustomed to field work. Avoid during high winds and thunderstorms. The trail starts at the recreational vehicle section of the Pine Springs Campground (0.8 km from the Pine Springs Visitor Center – check in at the visitor center, then turn right when leaving the visitor center parking lot). Follow the signs for Guadalupe Peak Trail. Follow the hiking trail; the horse trail adds about 1.5 km to the trip but is less steep.

Devil's Hall Trail - Hike up the stream-bed of Pine Springs Canyon, then climb the rocks of the Hiker's Staircase to the Devil's Hall, a narrow, scenic canyon. The trail is rocky but has little elevation gain. It displays a variety of woodland and desert vegetation. The trail is only 6 km round trip. It is a relatively easy hike.

The Bowl - A trail leads upward from the desert into a forest of pine and Douglas fir that covers high ridges and canyons. From Pine Springs campground, follow the Frijole Trail, and Bear Canyon Trail to the top, then left on the Bowl Trail. Take a side trip to Hunter Peak, then descend via Tejas Trail. This hike is considered rather strenuous. Allow 8-10 hours; round trip = 14.5 km.

El Capitan - Salt Basin Overlook Trails - A hike from Chihuahuan Desert to the base of El Capitan at the southern end of the Guadalupe mountain range. Follow the El Capitan Trail and the Salt Basin Overlook Trail. Return to Pine Springs campground via the El Capitan Trail. This hike is18 km round trip and is rated moderate. Allow 6-8 hours.

DeepKarst 2016 is organized by the National Cave and Karst Research Institute in cooperation with Karst Hydrogeology and Speleogenesis Commission of the International Union of Speleology

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