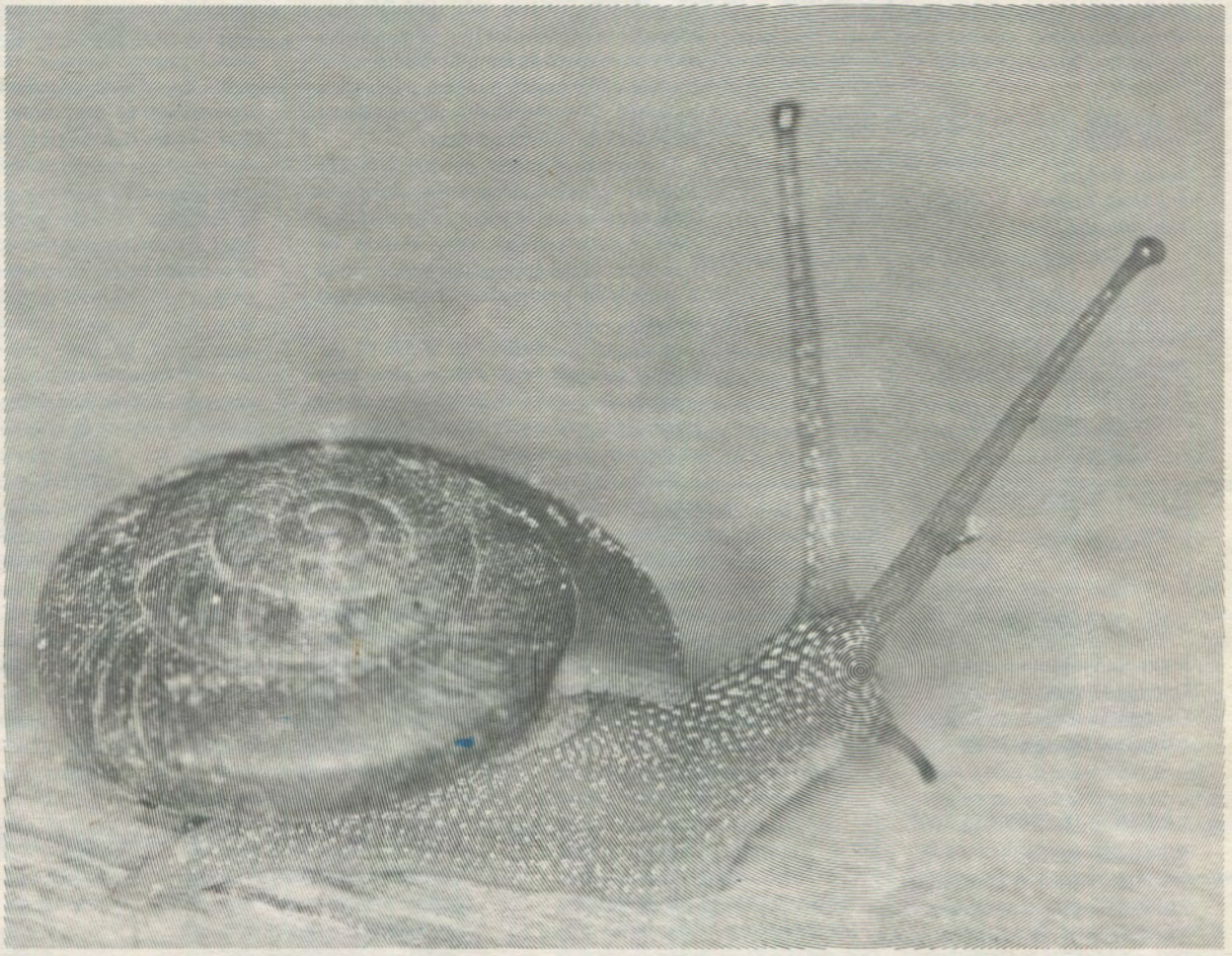
QUARTERLY JOURNAL OF THE NATIONAL SPELEOLOGICAL SOCIETY

THE NSS BULLETIN

ISSN 0146-9517



VOLUME 42 NUMBER 2 APRIL 1980

Contents

1979 NSS Convention, Abstracts of Papers **23**

Mesodon appresus Great Onyx Cave, Kentucky (Stewart Peck photo)

OFFICE ADDRESS

National Speleological Society
Cave Avenue
Huntsville, Alabama 35810

MANAGING EDITOR

James Hedges
Big Cove Tannery
Pennsylvania 17212

LIFE SCIENCES EDITOR

Francis G. Howarth
Bernice P. Bishop Museum
Box 19,000-A
Honolulu, Hawaii 96819

SOCIAL SCIENCES EDITOR

EXPLORATION EDITOR

Barry F. Beck
Geology Department
Georgia Southwestern College
Americus, Georgia 31709

EARTH SCIENCES EDITOR

William B. White
Materials Research Laboratory
210 Engineering Science Building
The Pennsylvania State University
University Park, PA 16802

ANTHROPOLOGY EDITOR

Patty Jo Watson
Anthropology Department
Washington University
St. Louis, MO 63130

CONSERVATION EDITOR

Thomas Lera
729 Nora Lane
Desoto, Texas 75115

The NSS Bulletin is published quarterly, in January, April, July, and October. Material to be included in a given number must be received at least 90 days prior to the first of the month in which publication is desired. The subscription rate in effect 1 August 1975: $10.00 per year.

Discussion of papers published in *The Bulletin* is invited. Discussions should be 2000 words or less in length, with not more than 3 illustrations; they should be forwarded to the appropriate editor within 3 months of publication of the original paper.

A voluntary contribution of $25.00 per page is solicited from authors after their manuscripts have reached page-proof stage. This represents about one-quarter of the cost of publication.

Entered as second-class matter at Huntsville, Alabama and at additional mailing offices.

Printing and Typography by

Adobe Press
Albuquerque, New Mexico

SELECTED ABSTRACTS OF PAPERS 1979 NSS CONVENTION PITTSFIELD, MASSACHUSETTS

BATS AS A PUBLIC HEALTH HAZARD — A SYMPOSIUM

Thomas Lera

729 Nora Lane, Desoto, Texas 75115

During the past 5 years, several cases of human rabies caused by bats have been reported. The most recent was in 1976, when a woman died of rabies after being bitten by a rabid Big Brown Bat. Although only 10 cases of human deaths from rabies transmitted by bats have been reported in the United States, the very nature of this disease attracts attention and, in turn, calls for the elimination of bat populations. However, there is no evidence that the destruction of bats and their habitats is effective in reducing the public health hazard from rabies transmitted by bats.

* The Symposium included two other papers: one by Charles E. Mohr of Delaware State College, which was withdrawn when the author was unable to be present, and one by Alvin Novick of Yale University, the edited abstract of which was not returned by the author. The Symposium was concluded by a panel discussion moderated by Thomas H. Kunz of Boston University. Several papers related to the Symposium will appear in a forthcoming issue of *The NSS Bulletin.*

RABIES IN BATS IN THE UNITED STATES

Charles V. Trimarchi

Division of Laboratories and Research
New York State Department of Health
Albany, New York 12201

The first confirmed-rabid insectivorous bat in the United States was reported in 1953. The number reported since has steadily increased, remaining over 500 each year since 1974. The disease has been reported in bats from all 48 contiguous United States and from all North American species of bats that have been adequately sampled. The geographic distribution is largely independent of that reported for rabies in terrestrial animals; 10 to 15 states each year report rabies exclusively in bats.

The incidence of rabies in bats, as revealed by surveys, is less than one percent. In bats submitted for rabies examination because of contact with man or pets, or because of unusual behavior, this figure varies regionally from 3% to 10%. The high rate in submitted specimens is in part a reflection of the greater contact between humans and sick bats.

Although generally two weeks to several months, unusually long incubation periods of over one year have been reported in captive bats. Naturally infected bats exhibit a variety of clinical signs, ranging from paralysis alone, to excessive vocalization and aggressiveness. This clinical illness generally lasts 3 to 5 days, terminating in death. It is during this period that the animal is capable of transmitting the disease. Early reports of bats as asymptomatic carriers of rabies have not been substantiated for our insectivorous species. Aerosol transmission of rabies virus from bats to man and other terrestrial mammals has been documented but is apparently dependent on unique conditions of animal density and high bat infection rates that are rarely encountered.

There have been eleven confirmed cases of bat-transmitted human rabies in North America. Perhaps more significant from a public health aspect is the large number of persons who undergo rabies post-exposure prophylaxis because of actual or suspected contact with bat rabies. The hazards associated with bats encountered in their normal habitat are minimal. However, a sick bat or any bat acting abnormally should always be treated as rabid; in the event of a bite, the wound should be promptly washed, and medical attention sought immediately. The animal should then be submitted to a local health department for examination.

THE RELEVANCE OF BATS TO THE SEARCH FOR A RABIES RESEVOIR

Merlin D. Tuttle

Vertebrate Division, Milwaukee Public Museum
Milwaukee, Wisconsin 53233

Several early studies seemed to implicate bats as asymptomatic carriers of rabies, and bat populations soon were labeled as being the "major reservoir" for rabies in other North American wildlife. A true carrier state was believed to exist, and aerosol transmission of rabies to carnivores that entered caves was suspected. Several non-field studies even claimed to show a direct correlation between rabies in foxes and the distribution of caves where bats were believed to live.

Amid much national and international publicity, which often presented hypotheses as if they were proven facts, many studies were initiated to investigate the claims. Several attempts to duplicate early studies that reported an asymptomatic carrier state failed, and it is now believed that virologists mistook a relatively harmless virus, the Rio Bravo Virus, for rabies.

Though aerosol transmission from bats to carnivores in certain Texas caves seemed likely, an investigation of carnivores, at the same caves where aerosol transmission was shown to be a possibility, failed to demonstrate the hypothesized bat-to-carnivore rabies transmission. Most rabid carnivores found in surrounding areas apparently had contracted the disease from other sources. Simultaneous studies investigated the possibility of natural transmission from bats to their predators via a direct bite route. However, experimental transmission by bite from rabid bats with infectious saliva to a wide variety of carnivores (including dogs and cats) proved extremely difficult.

Finally, several long-term field studies compared geographic areas according to reported incidence of rabies in bats versus in other wildlife and found a negative correlation. Areas of highest incidence of rabies in bats showed least rabies in other wildlife and vice versa. Such studies arrived at the same conclusion from Georgia in the United States to British Columbia in Canada. It is now also known that rabies in bats is extremely rare or absent in Europe and Africa, where rabies outbreaks in other wildlife are common.

Contrary to many expectations, numerous laboratory experiments as well as field studies have failed to support the once hypothesized role of bats as reservoirs for rabies. Although virologists who study rabies in bats no longer accept the idea that bats act as important reservoirs of rabies, the notion still persists in the minds of health officials and the public, often with unfortunate consequences.

CONFEDERATE NITRE PRODUCTION

John Powers

12017 Dalewood Drive, Wheaton, Maryland 20902

Caves played an important role in the Confederacy's bid for independence. The Confederate Ordnance Department (later, the Nitre & Mining Bureau) succes fully utilized the South's nume ous but scattered caves to produce an adequate supply of gunpowder, despite military, political, and logistic disadvantages. Potassium nitrate, an essential ingredient in gunpowder, was leached from the nitrous earth mined from saltpeter caves.

SALTPETRE MINING IN WEST VIRGINIA

Peter M. Hauer
(deceased)

Saltpetre mining in the Virginias became an important industry during the War Between the States, due to the scarcity of imported nitrates. The early settlers used cave soils to produce their private supplies prior to the War of 1812. Gun powder became a valuable trading commodity for the early settlers. Much of the art of producing potassium nitrate has been lost.

EDWIN SWIFT BALCH— ALMOST AN AMERICAN MARTEL

William R. Halliday, M.D.

1117 36th Avenue East, Seattle, Washington 98112

Today, Balch is largely remembered for his book, *Glacières, or Freezing Caverns*. At the time of his death, however, his speleological contributions were almost forgotten. This was because his interests were diverted into other fields just when he began to spread out from ice-containing caves to speleology in general. Further, nearly all his caving was in Europe; he had just begun exploring American caves when he was distracted from speleology. More than a half-century after his death, however, Balch's role in the advancement of speleology still remains incomplete.

HORACE CARTER HOVEY — AN UNFINISHED STORY

William R. Halliday, M.D.

1117 36th Avenue East, Seattle, Washington 98112

Much has been written about the contributions of the Reverend Horace Carter Hovey to American speleology. Yet, a number of puzzling questions remain. The recent discovery by Rick Banning of an annotated copy of the 1896 edition may have clarified the nature of the supposed second edition of *Celebrated American Caverns*, but Hovey's first two published articles and many later ones remain unlocated. The whereabouts of his personal files and library are unknown; they may be in crates at the American Musuem of Natural History.

A HISTORY OF ADIRONDACK AND NEW ENGLAND TALUS CAVING

Robert W. Carroll, Jr.

23 Pleasant Street, Apt. 4, Potsdam, New York 13676

Nonsolution caves have been known for centuries in the Northeast. The Indians and early white settlers used these cavities as temporary shelters and storage sites. This area has generated many odd stories about wolves, bears, counterfeiters, outlaws, "The Leatherman", and "bottomless" pits, but few people have made serious inquiries into these caves.

Most people do not consider these boulder piles and rifts as true caves. They believe them to be dangerously unstable and of only trivial importance but their significance has increased especially since 1970.

A BIASED HISTORY OF CAVE GEOLOGY IN NORTH AMERICA, 1879-1979

William B. White

Department of Geosciences and Materials Research Laboratory
The Pennsylvania State University
University Park, Pennsylvania 16802

Cave geology in the United States began in 1878-1879, with the descriptive writings of H.C. Hovey. Although some of the founding fathers of American geology (*e.g.*, Benjamin Silliman) had examined caves, their writings are casual, superficial, and generally unenlightening. The descriptive trend continued through the turn of the century, with the cave surveys of Blatchley in Indiana and, later, Bailey in Tennessee, White in Ohio, Stone in Pennsylvania, McGill in Virginia, and Malott in Indiana. Cave *science* (as distinguished from descriptive speleology) dates from the early 1900's and reached a crescendo in the 1930's with the publication of Davis' classic work and those of his critics: Gardner, Swinnerton, and Malott. These, however, are only highlights on a large body of professional work in the 1920's and 1930's dealing with cave origin, hydrology, and karst engineering problems (*e.g.*, the leaky Tennessee River dams). Bretz's 1942 classic marks the end of the era. There followed a hiatus of 15 years during which few new ideas were introduced.

The modern era of cave geology dates from 1957, the year in which the first process-oriented paper on cave origin was published. Organized caving groups, notably the NSS and CRF, played an important role in developing a new, more integrated, approach to cave science. Also important was *The NSS Bulletin* which, under the editorship of William E. Davies, took on the role of a scientific journal. Acceptance of cave geology papers in the mainstream geological journals followed in the middle 1960's. The shift of cave science from isolated investigators to university-based programs in the 1970's paralleled an increasing stream of M.S. and Ph.D. theses on cave-related topics. The number of cave-related theses each year has been increasing exponentially since the middle 1950's.

The scope of research broadened to include geomorphology, geochemistry, hydrology, sedimentation, mineralogy, and climatology as related to caves. High-quality research has been accomplished by recognizing the essential interdisciplinarity of cave-related sciences rather than by trying to establish speleology as compartmentalized, rather exotic, speciality by itself.

CAVERS AND BONE CAVES — 1949 TO 1978

R.E. Whittemore

4107 Ranch Road, Johnson City, Tennessee 37601

The caving community has made a significant contribution to the study of the Pleistocene history of eastern North America during the last 30 years through the discovery and excavation of several dozen important deposits of vertebrate fossils. Caves form one of the few types of environments in the Appalachians in which fossil animal remains may be accumulated, preserved, and protected from erosion. Since cavers frequent this environment, accidental discovery of some deposits is inevitable; however, the role of the caving community has been a far more active one:

(1) Descriptions and location data on caves accumulated by cavers have been used extensively by paleontologists in prospecting for new sites.

(2) The caving community has provided open channels of communication between cavers and caving paleontologists through publications, seminars, and informal gatherings.

(3) Paleontologists have drawn heavily upon the caving community for assistance in locating caves in the field, removing bone-bearing deposits, site mapping, and nearly every other aspect of their field operations.

(4) Cavers have developed many of the techniques used by paleontologists in getting around safely in caves.

A HISTORY OF ALABAMA CAVES AND CAVING

William W. Varnedoe, Jr.

5000 Ketova Way, Huntsville, Alabama 35803

The history of Alabama caving could possibly extend back to 1540, when Hernando DeSoto travelled through the state. The first written record of a cave is dated 1796. The Niter Mining Bureau of the Confederate Army used cavern soil to produce gunpowder, and there are sporadic records of individuals entering caves, but the systematic study of Alabama caves did not begin until 1930, when Dr. Walter B. Jones investigated ground waters in northern Alabama. Since then, the Alabama Cave Survey has flourished under the direction of men like Dr. Jones and William Varnedoe. The Alabama Cave Survey has issued many publications; nearly 2000 caves are recorded in its files.

A HISTORY OF CAVING IN THE VIRGINIA REGION OF THE NSS

Anne Whittemore

4107 Ranch Road, Johnson City, Tennessee 37601

The Virginia Region (VAR) holds a unique position in the Society's history. Not only was it the first regional organization to be formed, but the encompassing area served as the cradle of organized caving and the NSS. In addition, the VAR is the home of the two oldest grottoes still in existence, one of these being the oldest student grotto. The fun, the fellowship, and the unique spirit which holds Virginia Region cavers together is expressed in its stories, tales, and true adventures.

THE SCOPE OF PSEUDOKARST

Ernst H. Kastning

Department of Chemistry and Geology
Murray State University, Murray, Kentucky 42071

Pseudokarst phenomena are landforms, usually small in scale, that are similar in appearance to those created by karstification (chemical weathering, usually dissolution), yet in actuality are formed by other processes.

Physico-chemical processes responsible for the origin of pseudokarst include volcanic activity (lava tubes, lava molds, *etc.* and their surface expression), glacial activity (glacier caves and their surface expression), talus accumulation, cliff spalling, rifting, exfoliation, gravity sliding, rock expansion and compression, suffosion (piping), eolian abrasion, corrasion, grussification, littoral (shoreline) erosion, thermokarstification, biological excavation, and others.

KARST AND PSEUDOKARST: ON DEFINITIONS

Barry F. Beck

Earth Science Department, Georgia Southerwestern College
Americus, Georgia 31709

Karst has been defined as a distinctive assemblage of landforms due to solution of the underlying rock. Internal drainage is also frequently cited as a requisite for a karst terrain. Pseudokarst, then, is a terrain characterized by karst-like features but not formed by solution: Lava tubes, talus caves, and piping phenomena are simple examples. Solution, however, may be physical (halite in water) or chemical (limestone in weak carbonic acid), reversable (limestone in weak carbonic acid) or irreversable (limestone in weak sulfuric acid). Karst is documented for all these processes. In the formation of silikatkarren by the tropical weathering of granites and granodiorites, solution is partial; orthoclase, silica and potassium are removed in solution while hydrated alumina is left behind, yet the silikatkarren are indistinguishable from limestone karren. Because these are small-scale surface features, the criterion of internal drainage cannot be applied. Thus, it seems reasonable to extend the definition of karst to include *a distinctive assemblage of landforms arising from weathering reactions in which rock of any type is dominantly removed in aqueous solution*. Pseudokarst would then be an assemblage of landforms resembling karst but formed by processes where the dominant removal of material is not in solution. Volcanokarst, talus caves, and piping phenomena would still be prime examples.

DESCRIPTION AND MORPHOLOGY OF THE NORTHEAST'S LARGEST TALUS CAVES

Robert W. Carroll, Jr.

23 Pleasant Street, Apt. 4 Potsdam, New York 13676

The Northeast's twelve largest nonsolution caves — all with over 180m of passage — are described and compared with one another. None were described in the literature before 1970. These include three tectonic caves ranging from 210m to 550m in total passage length and nine talus caves varying from 190m to 3960m. The concept of cave "quality index" is introduced as a possible solution to the difficult problem of talus cave "quality" and as a tool for comparing different systems. Igneous and harder metamorphic rocks, boulder size, boulder arrangement, cirque versus pass topography, and source cliff size determine cave size and distribution. The configuration of tectonic caves is significant to interpreting their morphology.

Nonsolution caves in excess of 350 ft have been reported in sedimentary rock in Syracuse, "Southern Tier", and Schwangunk areas of NY State but have not been checked by the author.

25 Largest Northeastern Nonsolution Caves [as of 9/23/79]

13,050 ft. — TSOD, anorthosite, Essex Co., N.Y. +
5,300 ft. — MBDATHS, granites, Grafton Co., N.H. +
2,500 ft. — W.H. Lyman, anorthosite, Essex Co., N.Y.
*1,800 ft. — Eagle, Adk. gneiss, Hamilton Co., N.Y. +
1,250 ft. — Mt. Washington Snow Talus Maze, NH gneiss, Coos Co., N.H. +
1,200 ft. — Franconia Notch Slabs, red granite, Grafton Co., N.H.
1,150 ft. — Franconia Notch Coral, red granite, Grafton Co., N.H.
1,150 ft. — Mt. Adams Ravine, NH gneisses, Coos Co., N.H.
1,100 ft. — Saddleback Mtn., red granite, Franklin Co., Me.+
1,100 ft. — Manitou Abode anorthosite, Essex Co., N.Y.
1,050 ft. — Ice Gulch Nightmare Maze, red granite, Coos Co., N.H.
* 900 ft. — Stans-Drake, VT gneisses, Essex Co., Vt. +
* 700 ft. — "W Mtn.", Adk. red gneiss, Franklin Co., N.Y. +
620 ft. — Smugglers Notch Graffiti, schist, Lamoille Co., Vt. +
600 ft. — Deer Leap, schist, Rutland Co., Vt.
500 ft. — Hawkeye Porkie Maze, Adk. gneiss, Clinton Co., N.Y. +
500 ft. — Noncommercialized Lost River, granite, Grafton Co., N.H.
460 ft. — Henodoawda Gateway, anorthosite, Essex Co., N.Y.
450 ft. — Cow Hill, VT white granite, Caledonia Co., Vt.+
440 ft. — Mt. Marcy Cavern, anorthosite, Essex Co., N.Y.
420 ft. — Chemin Des Dames, NH gneisses, Coos Co., N.H.
* 400 ft. — near Eagle Cave, Adk. gneiss, Hamilton Co., N.Y.
* 400 ft. — near Eagle Cave, Adk. gneiss, Hamilton Co., N.Y.
* 350 ft. — Chiller, gneiss/schist, Windsor Co., Vt.+
350 ft. — Cat Gulch #9, Adk. gneiss, St. Lawrence Co., N.Y.

(* to left indicates fissure or tectonic cave)
(+ to right means cave is largest of any type known in that county).

THE TSOD ANORTHOSITE TALUS SYSTEM

Robert W. Carroll, Jr.

23 Pleasant Street, Apt. 4, Potsdam, New York 13676

The Adirondack anorthosite talus system known as "TSOD" has 13,000 ft of passage, perhaps 170 ft of relief, an airline spread 810 ft by 280 ft, and at least 445 intersections and 355 entrances.

STRUCTURALLY-CONTROLLED CAVES IN QUARTZITE, SHAWANGUNK MOUNTAINS SOUTHEASTERN NEW YORK

Eberhard Werner
Department of Geology, West Virginia University
Morgantown, West Virginia 26506

Douglas Medville
11762 Indian Ridge Road, Reston, Virginia 22090

A well-developed pseudokarst has formed on quartzites at two locations atop the Shawangunk Mountains, near Ellenville, Ulster County, New York. Several caves,, located entirely in the Silurian Shawangunk quartzite conglomerate, are partially roofed crevices. They probably formed as joint-bounded Shawangunk blocks slid down the western dip slope of a broad anticline. The western crevice caves extend up to 37 m below the local topographic surface and retain ice throughout the year. Water of undetermined volume flows along the bottom of two of the caves.

A set of crevice caves, at the southwest end of the east-facing erosion scarp of the Shawangunk ridge, close to the anticlinal crest, has been formed in the jointed conglomerate as a result of undercutting of the cliff face by sapping and subaerial erosion of the underlying Hudson River Shales.

Gravity sliding was probably facilitated along surfaces of shale partings or along the lower contact with the shale below the base of the Shawangunk conglomerate, although direct field evidence of this is difficult to obtain. Fracture permeability of the quartzite increased sufficiently, so that sinking streams and springs are now common. Movement of quartzite blocks may have originated from the force of ice overridding the area during the Pleistocene. Percolating water may have lubricated the contact with the underlying shale, allowing the blocks to slide under the influence of gravity. Gravity sliding may be continuing today.

ANOMALOUS SPELEOTHEMS IN NORTH-EASTERN TALUS CAVES

Robert W. Carroll, Jr.

23 Pleasant Street, Apt. 4, Potsdam, New York 13676

Until recently, speleothems were virtually unheard of and thought to be impossible in gneiss, granite, and anorthosite talus and tectonic caves in the Northeast. Today, a growing number of these caves are known to have a variety of "flowstone" and other types of secondary deposits. Most of these are less than 3 cm long or thick, but a few are over twice that size, and certain "non-flowstone" types are raising difficult questions as to under what conditions they were formed since the end of the last ice age.

PSEUDOKARST CAVES OF ARKANSAS

Albert E. Ogden

Department of Geology, University of Arkansas
Fayetteville, Arkansas 72701

Caves are common in the clean, friable, and poorly cemented Ordovician St. Peter and Everton sandstones of northern Arkansas. They are characteristically a single large room (up to 300 m long), are developed on a single plane with no side passages, and have large breakdown blocks covering a sandy floor. Speleothems may be present if carbonate rocks are near the roof of the cave.

The sandstone caves can be divided into three categories based on their mode of origin: (1) collapse, (2) piping, and (3) gravity sliding. The first two processes are often difficult to separate and commonly act simultaneously. The St. Peter and Everton sandstones are important confined aquifers in north-central Arkansas. Leakage from these aquifers to underlying carbonate members within the Everton may initiate solutional widening of joints that allows piping of sands and/or collapse of sandstone blocks into caves formed within the carbonates. Collapse of the St. Peter Sandstone into the Jasper Limestone member of the Everton, or collapse of the thick Newton or Calico sandstone members into other Everton carbonate members, is subsequently followed by upward stoping in the standstones and downward piping of insolubles.

The least common type of sandstone cave in the Ozarks is that formed by gravity sliding and joint infilling. The basal sand of the Pennsylvanian Atoka Formation is a massive unit that caps mountains. Widely spaced joints allow large blocks to break off and slide downward on underlying shales. Breaks between the blocks are subsequently partially filled with colluvium, forming caves known to be up to 370 m long. Devil's Den State Park caves in northwest Arkansas are of this variety.

GREENHORN CAVES, KERN COUNTY CALIFORNIA— AMERICA'S DEEPEST GRANITE CAVES?

Richard L. Breisch

110-A Dibb, China Lake, California 93555

The Greenhorn Caves in Kern County, California occur in a fault zone in Mesozoic igneous rocks; largely quartz diorite. Greenhorn Creek sinks underground and resurges over 700 m away and 201 m lower. The Greenhorn drainage basin has an area of 21.5 km^2. Several caves intersect the underground stream, and if these cave segments are eventually connected, this will undoubtedly be the deepest granite cave in the United States.

Passages of this "purgatory" cave are fault-controlled and contain boulders up to 5 m in diameter. Greenhorn Creek runs through the cave all year long, but its flow is highest during snow melt when quartz gravels, some containing gold, are deposited in the cave.

The caves were probably discovered in the early 1850's, shortly after gold was discovered in 1851 along Greenhorn Creek. Within two years, this area became the county's most important gold producing region of that time. Placer mining claims still exist in and around the cave.

LOST CREEK PSEUDOKARST, PIKE NATIONAL FOREST, COLORADO

Dave Allured

1300 30th St., Apt. B4-21, Boulder, Colorado 80303

Lost Creek flows through a spectacular granite pseudokarst area within Pike National Forest, in the Front Range of central Colorado. The deeply incised Lost Creek Canyon is surrounded by many large cliffs and filled with a jumble of enormous boulders. In a 6.5km section, 11 talus saddles up to 60m thick and 800m long bridge and encase the creek. As a result, not only do typical talus caves abound, but the creek's corrasional action in its subterranean granite watercourse has bored smooth-walled trunk passages of remarkable dimensions that resemble solutional trunk passages in carbonate caves.

TEXAS PSEUDOKARST, A DIVERSITY IN DISTRIBUTION, MORPHOLOGY, AND ORIGIN

Ernst H. Kastning

Department of Chemistry and Geology
Murray State University, Murray, Kentucky 42071

The most common pseudokarstic process in Texas has been mechanical suffosion (piping). The state's largest suffosion cave is Catarina-Confusion Cave, in Palo Duro State Park, Randall County. It has developed headward into relatively recent landslide deposits at their contact with the underlying Quartermaster Formation (Permian), a sequence of redbeds, sandstone, and shale. The cave is dendritic upstream, and has been partially eroded into the Quartermaster. Smaller suffosion caves are located in Brewster County (Study Butte Pseudokarst), Freestone County (Bonner Cave), and Cameron County (Model T Cave, a recently developed and destroyed anthropogenetic example).

Two other examples of clastokarstic caves have formed by contemporaneous dissolution and suffosion. Caves in the Tertiary Ogallala Formation in Lubbock County (High Plains) and Lake Corpus Christi Cave in the Pliocene Goliad Formation in San Patricio County (Gulf Coastal Plain) have developed through ground-water dissolution and removal of caliche cement from interstices in gravel, sandstone, and siltstone, and subsequent suffosion of disaggregated grains.

Pseudokarst at Enchanted Rock State Park, Llano County, and other areas of the Llano Basin represents a variety of forms associated with physico-chemical weathering of granite. Gnammas, the granitic counterpart of kamenitzas, are abundant on gently sloping surfaces. They arise from buttressed expansion of exfoliated slabs, chemical weathering, and deflation. Compressional forces among some slabs have created A-tent caves. Well-known Enchanted Rock Cave, more than 300m long, is the product of fracturing, grussification, suffosion, and talus accumulation.

Rock-city caves and crevices have been reported from Pennsylvanian rocks in Palo Pinto County and from Cretaceous rocks in Bosque County. These have originated by gravity sliding.

FURNACE CAVE, INYO COUNTY, CALIFORNIA —THE LOWEST CAVE IN THE WESTERN HEMISPHERE

Ernst H. Kastning

Department of Chemistry and Geology, Murray State University
Murray, Kentucky 42071

The lowest point yet attained in any western Hemisphere cave (52m below sea level) is in Furnace Cave, Inyo County, California. The cave was bottomed on 2 July 1975 by Robert Burney and the author. Exploration was hampered by cave air temperatures which exceeded 43°C (110°F), yet the humidity was remarkably low. The cave, whose entrance lies within a large gully, receives considerable runoff during storms, but all available moisture is rapidly removed by evaporation. A crawlway at the bottom continues to a lower depth and could be entered with minimal excavation of clastic fill.

Furnace Cave has developed by suffosion (piping), erosion, and mass-wasting. Nearly the entire vertical extent of the cave is within a poorly cemented sandstone derived from Quaternary alluvium. The cave has been protected from erosion by a caprock of alluvial-fan material consisting of moderately sorted conglomerate. Parts of the cave are unstable. The depth record may soon be nullified by further erosion.

CAVE ECOLOGY, COLLEGE COURSE AT MALHEUR (OREGON) FIELD STATION

Ellen M. Benedict

Portland State University, Portland, Oregon 97207

This course, a spin-off of the Malheur Cave Ecosystem Study, arose out of the need for novices-to-caving to learn about the scientific study of caves. In 1972, graduate students conducting a study of Malheur Cave, organized a two-hour seminar entitled "Cave Ecology" at Portland State University which included two week-end field trips to limestone and lava tube caves. The present six term-hour course, now in its sixth summer at the Malheur Field Station, involves three weeks of field and classroom study of basic ecological principles as applied to cave environments and organisms; of geological features of lava tubes, limestone, aeolian, littoral, and ice caves; of cultural and historic uses of caves; of conservation and management problems; and of safety practices. Group field projects during one-to eight-day trips in the Malheur-Bend area provide practical experience in surveying and mapping caves and surface features, measuring chemical and physical parameters, surveying geologic and biotic resources, and learning safety and vertical techniques.

Students have come from all parts of the world. Classes are kept small to permit close interactions: 1974 (5 students), 1975 (10 students), 1976 (8 students), 1977 (12 students), and 1978 (6 students). Of the 41 students to date, 25 have been female and 17 have been male. Six belong to the NSS and 17 have belonged to a NSS grotto for at least one year. One has since served as a tour guide in a commercial cave. Two are now conducting research projects in Washington lava tubes.

EVOLUTION OF CAVE-DWELLING ANIMALS

Susan A. Foster

Mount Hood Community College
Gresham, Oregon 97030

Cave-adapted animals are classified according to their degree of specialization: *troglobites* or obligate cavernicoles, *troglophiles* or facultative cavernicoles, and *trogloxenes* or animals regularly found in caves but which do not complete their life cycle there. *Accidentals*, as the name implies, get into caves but are not specialized. *Epigean* is the term used for surface forms. *Evolution* is the process of natural consecutive modifications in the inherited make-up of generations of organisms; it is the process by which modern forms have arisen from past forms. Many ideas explaining the occurrence of cavernicoles are based on Lamarkian theories. Ideas developed by Barr and Mitchell provide considerable information about the various cavernicoles which one encounters in caves.

A STATUS REPORT ON A LONG TERM ECO-SYSTEM STUDY OF MALHEUR CAVE HARNEY COUNTY, OREGON

Ellen M. Benedict, John E. Palmer, Patricia L. Barnhart, and Esther H. Gruber

Portland State University, Portland, Oregon 97207

The biota in western lava caves are largely ignored because they are not as conspicuous as the cavernicoles of other regions. Thus, Malheur Cave, a 3137-ft-long unitary lava tube, is very unusual in several significant ways. First, cave adapted animals have been discovered there: a pseudo-scorpion (*Apochthonius malheuri* Benedict and Malcolm), a flatworm (*Kenkia rhynchida* Hyman), an amphipod (*Stygobromus hubbsi* Shoemaker), an aquatic isopod (*Asellus* sp., Lewis Det.), a semi-terrestrial isopod, a palpigrade, and several species of collembola and of mites. Secondly, Malheur Cave contains a lake which has a maximum measured depth of 23 feet and is 1300 ft long by 10 to 40 ft wide; it lengthens 800 ft toward the entrance as the water rises 3 ft during October through May. Thirdly, thousands of measurements have been made in this cave since 1973 in the attempt to understand the presence of cavernicoles in a region where most other lava caves apparently lack a specialized fauna.

The descending passage, the large (7 ft by 30 ft) single entrance, the thin overburden (6 to 20 ft), and the large, relatively unobstructed passage in the first 600 ft of the tube, all suggest that the temperature in the True Dark Zone should be lower than the mean annual surface temperature of the region (8°C). The rare occurrence of ice stalagmites in the first 200 ft of the tube also provides visual confirmation that Malheur Cave is a cold-trap lava tube. Yet, air temperatures of the True Dark Zone are 16.0 to 18.9°C and water temperatures are 16.0 to 17.5°C, all within the range of nearby geothermal springs. Ion and geothermometric analyses of lake waters give a minimum estimated deep (2000 to 5000 ft below the cave) resevoir temperature of 75°C. Thus, the unusual heat in Malheur Cave comes from upwelling geothermal waters mixed with cool ground waters.

*This study was supported, in part, by 1974 and 1979 Research Advisory Committee grants.

THE ROLE OF THE VIRGINIA CAVE COMMISSION

John M. Wilson

7901 Dalmain Drive, Richmond, Virginia 23228

The Virginia Cave Commission was established by the Virginia General Assembly to carry out the following functions in 1979 and 1980:

A. Serve as an advisory board to any requesting State agency on matters relating to caves and karst.
B. Conduct an inventory of publicly-owned caves in Virginia.
C. Provide cave management expertise and service to requesting State agencies, including the preparation of management plans for non-commercial caves on publicly-owned property.
D. Identify all significant caves in Virginia and report any real and present danger to such caves.
E. Provide cave data for use by State and other governmental agencies which prepare or review environmental impact statements and land use plans.
F. Publish, or assist in publishing, articles, pamphlets, brochures or books on caves and cave-related concerns.
G. Facilitate data gathering and research efforts on caves and perform such other functions as may be deemed necessary in keeping with the purposes of this article.

The Virginia Cave Commission was also asked to study the following:

A. Ways in which State agencies can assist local authorities in obtaining the assistance of experienced cavers to help them in cave rescue situations.
B. Ways in which the State can encourage private individuals and conservation groups interested in cave conservation to purchase and protect significant caves in danger of being destroyed.
C. Virginia laws relating to cave ownership, in order to clarify ownership rights and determine potential liabilities.
D. Ways and means of making cave data available through an electronic data storage and retrieval system, in order to assist public agencies in making decisions directly or indirectly affecting caves.
E. The need for and desirability of a State cave recreation plan.
F. Ways in which the Virginia Cave Protection Act can more effectively be enforced.
G. The use, present and future, of Virginia caves as civil defense shelters.
H. Ways in which the State can advise the public about the legal protection given to caves under the law and the penalties for violations of those laws.

CAVE RESOURCES AND THE ARCHAEOLOGICAL RECORD: SOME ADDITONAL CONSERVATION ANALOGUES

Mark Grady
(deceased)

A number of presentations and papers in the recent past have emphasized the value of cave conservation approaches derived from those already demonstrated to be effective in conservation archeology. In an effort to further this perspective, a series of more refined parallels is drawn between the preservation of archaeological manifestations and the conservation of cave resources. Some successes and failures on the part of conservation archaeologists in dealing with the general public, land managers, and the archaeological profession are considered, and recent conservation research in caves threatened by the New Melones Reservoir is used as an example of the specific application of aspects of this perspective. The NSS is singled out as the organization having the most potential to promote cave conservation in a broad-based and responsible fashion.

LITTLE BEAR CAVE, ARKANSAS

Albert E. Ogden

Department of Geology, The University of Arkansas
Fayetteville, Arkansas 72701

Little Bear Cave is located within the cherty Boone-St. Joe Limestone of Newton County, Arkansas. Until 1976, this well-known cave was unmapped and believed to be only about 2,000 feet long. In 1976, Rodney Tennyson, a local caver, noted a breeze issuing from a small mud crack. He and friends began a tedious dig that, after several tortuous trips, completed a 25-ft long mud tube that opened into the "New Section."

Entrance to the "Old Section" of Little Bear is gained through a cherty belly crawl, at the base of a small cliff, within a broad doline. After squeezing down through the "Corkscrew," one enters the "Big Room." A complex series of breakdown crawls and pits lead off. The initial surveying was along a circular route through random, large slanting rooms connected by cherty belly crawls, climbdowns, and short pits that circumscribed the surface doline. Four large and decorated rooms, up to 400 ft long and 100 ft wide, exist along this 1400-ft route. At the bottom of the Big Room, a 70-ft pit leads to an additional 700 ft of large, decorated passage, at a level far below that of the rest of the cave.

The initial squeeze through the "ball cruncher" led Tennyson to the mud slit that was dug and termed the "Auger Hole." The "New Room" then led to the highly-decorated "Eagle Room", a 600-ft long, 150-ft wide, 40-ft high passage. AT the end of the Eagle Room is the "Blowhole Squeeze" that, after approximately 1000 ft of passage, ends in the large, decorated "Last Room." Fifteen, eight-hour and longer mapping trips have yielded 7,283 ft of passage.

KARST AND CAVES IN THE GUNONG MULU NATIONAL PARK, SARAWAK, EAST MALAYSIA

Michael J. Day

Department of Geography, University of Wisconsin
Milwaukee, Wisconsin 53201

The karst of Sarawak is not well known but is, perhaps, the most impressive in the world. The 1977-1978 Royal Geographic Society expedition to the Gunong Mulu National Park provided geomorphologists and speleologists with the opportunity to study further this important area.

Many of the limestone landforms are spectacular. Much of the surface is deeply fissured, highly irregular, or traversed by steep ridges of extreme sharpness. Elsewhere, large, steep-sided enclosed depressions pit the surface; one such depression, named Sendirian, has a vertical entrance drop of 150m. The deeply-etched nature of the surface is climaxed by the development of the Pinnacles—spectacular spires rising up to 35m through the forest-covered slopes of Gunong Api and Gunong Benarat. Limestone towers protrude through the alluvial lowlands, and incised gorges traverse the limestone massif.

The caves of Mulu are among the most magnificent in the world. Outstanding are, Deer Cave, (Gua Payau) and Clearwater Cave (Gua Terangair). Deer Cave is, basically, a single passage 1 km in length, but it is nowhere less than 100m high and wide. At its downstream end, the passage is 190m wide and nearly 140m high. The roof contains 35m diameter avens in its upstream half.

Clearwater Cave is perhaps the most important yet discovered in the Park area. Dimensions are again enormous, and over 25km of passage have been explored.

THE STEPHEN HOUSE CONGDON EARTH SCIENCES CENTER, ARIZONA-SONORA DESERT MUSEUM

William Panczner and Anna Pollard

Curator of Earth Sciences, and Earth Sciences Interpreter
Arizona-Sonora Desert Museum, Tucson, Arizona 85704

The Earth Sciences Center at the Arizona-Sonora Desert Museum includes offices, laboratory, and a wet and dry cave. Construction began in 1974. The artificial "rocks" from which the cave is made are built on a framework of pipe, re-inforcing rod, and metal lath. A layer of gunite concrete was sprayed on, followed by a layer of colored plastic cement and sand textured to resemble the desired rock type. Paint applied with spray guns or sponges enhanced the realistic appearance. The "speleothems" in the wet cave pool area are polyurethane foam sprayed on and hand-carved for detail, covered with epoxy resin for a 'wet' look, and sand-blasted to weather the surface. The complex has taken on such a natural appearance that native desert plants encroached over and around the caves, and squirrels, lizards and birds are accustomed to it.

The caves were opened to the public in 1977. Their cost, thus far, has been about $750,000. At least two million people have passed through the caves since their opening. In 1978, the caves experienced 80% of the attendance for Carlsbad Caverns for the same year. The Center features adult and school tours upon request, in-cave interpretation, and workshops and featured events for Museum members and visitors.

With the aid of the Escabrosa Grotto of the National Speleological Society, the Center has developed a public awareness for cave conservation. The final message a visitor receives upon leaving the caves is etched in a metal plaque:

Fragile — Handle With Care. The fragile environment of a cave is one of the Earth's non-renewable resources. Once its beauty is destroyed, it can never be replaced. If you visit a cave, please treat it gently. Future visitors will thank you for your care.

NEW DISCOVERIES IN MCFAIL'S CAVE

Warren Hall

101-C Edgewater Park, Bronx, New York 10465

McFail's Cave is the largest cave in the Northeast and the first cave owned by the NSS. It has been known since the early 1800's, but it wasn't until the 1960's that it was opened up to it's current 5-mile length. The difficulties of McFail's caving precluded any other major discoveries until 1977, when a search for a new entrance near the heart of the system led to new passage and high adventure above Nethaways dome. Nineteen Seventy-eight saw the long-awaited discovery of a new entrance, high above Coeymans' Dome. The Hall's Hole Entrance has enabled NRO cavers to reach the areas with greatest potential for new discoveries more quickly and in better condition. The cave is currently undergoing active exploration by Northeastern cavers.

COLDWATER CAVE, IOWA

Pat Hopper

301 No. Springer, Carbondale, Illinois 62901

Coldwater Cave, Iowa's longest known cave, is located in the northeastern corner of the state. It was discovered in 1967 by David Jagnow and Steve Barnett of the Iowa Grotto and was explored and mapped by them between 1967 and 1969, amid great secrecy. Jagnow and Barnett subsequently interested the State in studying the cave with a view toward eventual purchase and development, but the cost was found to be prohibitive.

More recently, the Rock River Grotto and other grottoes have continued exploration and mapping in Coldwater cave. Many questions remain unanswered, and further discoveries may be made.

CAVES AND KARSTS OF QUEBEC

Jean Roberge

c/o Société Quebéçoise de Spéléologie
1415 rue Jarry est, Montreal, Québec, Canada H2E 2Z7

An organized survey of Quebec caves and karsts, started 9 years ago, has produced a rather complete inventory of limestone, dolomite, and gypsum surfaces in Quebec. As expected, our knowledge about each of these surfaces is usually proportional to its accessibility and to its density of human occupation. For that reason, very little is known about caves and karst above latitude 50°N.

Below that latitude, almost all known caves and karsts occur in these three formations:

a)—platform carbonates of the lowlands (Ordovician and Silurian limestones),

b)—metamorphic Grenville carbonates (late Proterozoic marbles), and

c)—Appalachian folded carbonates (Cambro-Ordovician limestones and limestone conglomerates and Siluro-Devonian limestones).

During the Wisconsinan stage, Quebec was completely covered by the Laurentide Ice Sheet. Its southern part became ice-free between 13,000 and 10,000 years BP. Ice retreat was followed by marine invasion of the lowlands. These post-glacial seas affected a major portion of the platform carbonates and a small part of the other karstic rocks.

Roughly 150 solutional caves between 10m and 1.5km long are known in southern Quebec. Most of them seem to be Holocene in age. These are directly related to, and a consequence of, the contemporaneous drainage system. In the St. Lawrence lowlands, many are associated with canyon-forming rivers. Most of them are active. These are mainly subhorizontal caves; their depth rarely exceeds 20m. A typical gallery shape is the relict phreatic tube more or less entrenched by an active vadose channel. The more common sediments observed are recent fluvial silts, sands, and gravels. Very few speleothems are found in these young caves. Typical cave temperatures in Quebec vary between 4° and 6°C.

A small fraction of Quebec caves seems to be much older. These caves show no significant relation to today's drainage. Their passages present a typical phreatic morphology. Inclined or vertical elements are not uncommon. Massive sediments often partially or completely fill certain galleries. Calcite precipitates are more important in such caves, often occurring as moonmilk. We tend to consider these caves pre-Wisconsinan in age. ^{230}Th-^{234}U dates recently obtained on stalagmite samples from one of those show that it is older than 200,000 years.

Surface karst is usually present as local, minor solutional features (karren, limestone pavements, sinks, resurgences, dry valleys, dolines). However, some intensively karsted areas have been observed, such as "Karst du Synclinal du Lac Matapedia" (Bas St.-Laurent) and "Karst de la Haute-Saumons" (Ile d'Anticosti). The first is an old karst with many caves plugged by sediments. It is partially re-used and rejuvenated by today's drainage. The second is a young karst expanding rapidly under very low hydraulic gradients. It has no important accessible caves. Both have underground drainage channels longer than 10km.

CAVES OF BLUE ROCK MOUNTAIN, NORTH CAROLINA

Joel B. Stevenson

103 Oak Terrace, Arden, North Carolina 28704

Blue Rock Mountain is located at the southeastern edge of the Blue Ridge Escarpment. The tectonic caves there are the most extensive of that type known to the author. Despite considerable tourist development in the region, they have been neither developed nor extensively studied.

Their exploration can be divided into three periods: 1)—sporadic exploration prior to 1971, about which little is known today; 2)—exploration and mapping by members of the Flittermouse Grotto from 1971 through 1975; and 3)—the new discoveries and remapping from 1978 to date.

VALLEY PROFILES AND EROSION LEVELS IN THE SWAGO CREEK — LITTLE LEVELS — FRIARS HOLE KARST, WEST VIRGINIA

William B. White and Elizabeth L. White

Department of Geosciences and Materials Research Laboratory
The Pennsylvania State University
University Park, Pennsylvania 16802

The field area considered is the segment of the Greenbrier limestone karst on the eastern margin of the Allegheny Plateau extending from the Swago Creek basin on the north to the Friars Hole karst on the south. Extending through the area, beveling geologic structure, is a karsted erosion surface represented most extensively by the Little Levels (a sinkhole plain) in the central portion of the area. Base level is determined by the Greenbrier River, incised some 90 to 120 m below the erosion surface and flowing generally north to south along the eastern margin of the area. Drainage from the high mountains to the west is roughly to the east, but individual streams with steep upstream reaches become deranged at the karst border. In addition, the Friars Hole karst involves a north-south trending dry valley with major reorientation of the subsurface drainage to the south through the Friars Hole Cave system.

The deciphering of the drainage system is attempted by fitting the profiles of the tributary surface streams to exponential functions. The profiles appear (usually) as either a single straight line or as a series of line segments. The breaks between segments can correspond to changes in bedrock erosion resistance but more often record changes in base level. The upstream segments for several of the streams can be extrapolated to reveal an early stage in the drainage history when the tributary stream were graded to the 760 m erosion surface. The coefficient of the exponent in

$$E = E_0 e^{-bd}$$

where E = elevation and d = distance downstream from divide gives a measure of the steepness of the stream channel. Numerical values range from $b = 0.54 \times 10^{-4}$ to 7.02×10^{-4} m^{-1}. The complex drainage history of the Friars Hole karst is revealed in nonexponential tributary stream profiles and multiple segments in other profiles. There is some evidence that there was a well-integrated drainage system graded to the base level corresponding to the 760 m erosion surface, which may be of Tertiary age.

OPTIMUM LEG DISTANCE FOR MINIMUM TRAVERSE ERROR

Rane L. Curl

Department of Chemical Engineering, University of Michigan
Ann Arbor, Michigan 48109

The analysis of cave surveying errors by Irwin and Stenner (1975) has been corrected and refined to determine the contributions to traverse error from station location, azimuth, and distance errors. Because station and distance errors accumulate as the number of stations increase but the cumulative contribution from azimuth errors decreases with increasing number of stations (for the same total traverse length), there is an optimum leg distance L_o that minimizes the total traverse error. This is given by

$$L_o = \left[\frac{0.5\sigma_s^2 + \sigma_d^2}{\sigma_\phi^2} \right]^{0.5}$$

where σ_s, σ_d, and σ_ϕ are the station, leg distance and azimuth (radians) standard errors, respectively. If $\sigma_s = 1$cm, $\sigma_d = 1$cm and the compass is read to one degree ($\sigma_\phi \doteq 0.005$ radians), the optimum leg distance is about 2.5 m. Longer 'shots' will degrade the total traverse accuracy, despite the fact that they would lead to fewer stations.

REFLECTANCE SPECTRA AND COLOR IN CALCITE SPELEOTHEMS

William B. White

Department of Geosciences and Materials Research Laboratory
The Pennsylvania State University
University Park, Pennsylvania 16802

Calcite in its pure form is white. White speleothems are rare; most are colored shades of yellow, tan, and brown. Occasionally, blood-red dripstone is found, and, still more rarely, green and blue speleothems occur. Possible sources of speleothem color include: iron group ions substituting for Ca^{++} in the calcite structure; included clay, silt, and metal oxides (mostly of iron and manganese) between the calcite crystals; hydrated iron oxide stains along grain boundaries; and organic stains incorporated into the growing crystal. Gascoyne has challenged the long-held (but unsupported) view that the common yellow to brown colors are due to iron oxides and advances organic stains as the dominant colorant. This investigation follows up these ideas. The technique used is diffuse reflectance spectroscopy, which permits one to extend his "color vision" into the near-infrared.

Pure calcite exhibits a complex spectrum in the 1.4 to 2.5 μm region due to incorporated water either as water-filled voids within the calcite crystals or adsorbed on grain boundaries. Characteristic d-electron spectra of the iron-group elements were found in a few cases: Ni^{++} from yellow Timpanogos Cave calcite, Cu^{++} from several Arizona caves and from the Grotte Bleue in France, and VO_4^{++} from another Arizona cave.

The spectra of hematite, goethite, and other iron oxide hydrates all contain a characteristic band in the 850 to 950 nm region. This band also appears in the spectra of iron oxide speleothems from Porters Cave, Pa. and Butler Cave, Va. and from the hematite-stained boxwork formations from Wind Cave, S.D. The spectra of most yellow and brown speleothems are featureless in the 700 to 1400 nm region. The characteristic 900 nm band of the iron oxides is systematically absent. The conclusion is that the almost universal yellow to brown colors of most speleothems are not due to iron oxides. Organic stains are the alternative that must now be investigated.

STRUCTURAL, LITHOLOGIC, AND TOPOGRAPHIC CONTROLS ON THE ORIGIN OF NATURAL BRIDGE CAVERNS COMAL COUNTY TEXAS

Ernst H. Kastning

Department of Chemistry and Geology
Murray State University, Murray, Kentucky 42071

Natural Bridge Caverns ("NBC"), Comal County, Texas consists of 3 segments of a once larger cave now truncated by doline collapse. Its origin is intimately related to the lithologic and diagenetic character of the Lower Cretaceous carbonate sequence and to tectonism associated with the San Marcos Uplift and the Balcones Fault Zone.

Uplift of the San Marcos Platform at the close of the Early Cretaceous exposed the uppermost Edwards Limestone to subaerial erosion. Groundwater flow initiated poorly-integrated solution cavities in this unit and in the underlying Walnut and Glen Rose formations. During the remainder of the Cretaceous, the region was covered by shallow marine waters, Upper Cretaceous beds were deposited, and solutional enlargement ceased. Regional uplift of the Edwards Plateau during the early Tertiary promoted a series of events that led to the development of NBC and other nearby caves: (1) regional (Balcones) faulting created northeast-trending fractures that were overprinted on a pre-existing northwest-trending fracture set related to the San Marcos Uplift, (2) a new base level established to the southeast promoted incision of surface streams and integration of groundwater flow in response to higher hydraulic gradients toward springs, and (3) solution conduits were integrated along the two joint sets and within zones of enhanced porosity created during the Cretaceous.

A lower-level master conduit developed in the Glen Rose Formation, oriented downdip toward the Bat Cave Fault. Here, flow was diverted northeastward along the fault trend. Enlargement of the conduit led to collapse of ceiling beds, upward stoping of the cave passage, and blocking of lower-level drainage by collapse debris. Diversion channels formed in overlying strata of favorable lithology and fracturing. Lowering of the piezometric surface upon stream incision led to drainage of the cave and to speleothem deposition. Pluvial climates during the Quaternary resulted in periodic flooding of the cave and redissolution of the speleothems.

BERMUDA CAVE DIVING

Thomas M. Iliffe

Bermuda Biological Station, St. George's West, Bermuda

The island of Bermuda is a mid-ocean volcanic seamount capped with marine and aeolian limestones. The volcanic rock is about 30m below sea level under the most cavernous part of the island. During the Pleistocene, when sea level was as much as 100m lower, the caves probably acted to funnel runoff from the interior of the island beyond the fringing reefs. The largest of these caves may lie at the limestone-basalt interface. The surface caves of Bermuda are thought to have resulted from the partial collapse of these huge underlying solutional voids. Access to the deeper solutional system may be possible through the approximately 75 to 100 tidal, salt water cave pools. Some of the solutional passages may even extend into the volcanic caldera underlying present-day Castle Harbour. A systematic exploration of Bermuda's submerged caves may answer signficant questions regarding speleogenesis, hydrology, and sub-sea level stratigraphy.

GEOCHEMICAL ANALYSIS OF HARRISON SPRING, HARRISON COUNTY, INDIANA

Jeffrey Ehrenzeller and Donald W. Ash

Department of Geography and Geology
Indiana State University, Terre Haute, Indiana 47809

A geochemical analysis was undertaken for 23 water samples collected at Harrison Spring from June, 1977 through May, 1978. Atomic absorption and on-site water chemistry analytical methods were employed for the study of the samples. It was discovered that the following chemical species within the water varied inversely with discharge at Harrison Spring: Na^{+}, Cl^{-}, and SO_4^{2-}. Other chemical and physical parameters, total hardness, Ca and Mg hardness, alkalinity saturation with respect to calcite, and conductivity also varied inversely with discharge according to regression equations of the form $y=(-a)*\log x + b$. Seasonal trends were noted in pCO_2, total Ca and Mg hardness, alkalinity and saturation of the water with respect to calcite. The high pCO_2 values encountered during October, November and January were believed to account for the higher readings of total Ca and Mg hardness and alkalinity during the same months.

Finally, the denudation rate of the limestone within the Harrison Spring basin was calculated using determined Ca mass flow rates (g Ca/min) in conjunction with mean monthly discharge from the spring. It was calculated that approximately 2,468 m^3 of limestone were removed from Harrison Spring basin from June, 1977 through March, 1978. Roughly 36 percent was removed during summer and early fall while 64 percent was removed between November and March. The higher rate of limestone dissolution that occurred between November and March was attributed to higher pCO_2 values and the availability of comparatively more water during that period.

HYDROLOGICAL ANALYSIS OF HARRISON SPRING, HARRISON COUNTY, INDIANA

Donald W. Ash and Jeffrey Ehrenzeller

Department of Geography and Geology
Indiana State University, Terre Haute, Indiana 47809

The Harrison Spring subsurface drainage basin, located within the Crawford Upland in south-central Indiana, is developed on a relatively thick sequence of Middle Mississippian limestones which dip gently to the west. Harrison Spring, the largest karst spring in Indiana, drains approximately 68 sq mi of the Mitchell Plain.

Results of fluorescein and Rhodamine WT dye-tracing tests carried out within the basin between 1968 and 1978 were utilized in part to delimit the size of the drainage basin. Dye-tracing tests from the sinks of Indian Creek to Harrison Spring revealed flow velocities within this underground conduit that range from 17.2 ft/hr at low flow to 902 ft/hr at higher flow periods. Where dye-tracing data were lacking, surface drainage features were utilized to make estimates of the basin boundaries.

The average discharge of the spring during the period of study was 117 cfs. Discharges during the study ranged from a low of 92 cfs to a high of 730 cfs. Since greater than average amounts of precipitation fell over the basin during the study period, low discharge readings of 8.53 and 29.9 cfs recorded by the USGS in 1968 and 1969 respectively were not encountered.

Calculated monthly water balances for Harrison Spring basin were used to substantiate the 68 sq mi basin size determined by dye-tracing tests and examination of surface drainage features. It was found that the water balance during the months of August, October, November and January substantiated a basin size of 68 sq mi. However, during July, February and March, the large amounts of water released from storage that were required to meet the water balance indicated a larger basin size. Analysis of baseflow regimen of Harrison Spring based on minimum monthly discharge per unit area of basin showed storage capacity values up to twice as high as those recorded in an earlier investigation of the Orangeville Rise, another karst basin in south-central Indiana.

SPELEOGENESIS IN SINKING FORK, TRIGG COUNTY, KENTUCKY

Florence Moore and John Mylroie

Department of Chemistry and Geology
Murray State University
Murray, Kentucky 42071

A broad sinkhole plain covers most of Trigg County, Kentucky. A karst surface developed on Mississippian limestone exists at an average elevation of 500 ft ASL and is incised by local master streams to an altitude of 350 to 400 ft ASL. One of these master streams, the Sinking Fork of Little River, was examined in detail.

Incision of Sinking Fork resulted in the establishment of entrenched meanders. A history of subsurface meander cut-offs followed. Diversion of stream flow through one meander neck resulted in the abandonment of that meander by Sinking Fork. Meander cut-off caves upstream from that meander and feeding that meander were also abandoned. Further downcutting by Sinking Fork has perched the abandoned meander cut-off caves and breached the active one. A large, more recent meander cut-off cave has been delineated by cave exploration and dye tracing. During low flow, Sinking Fork travels entirely through this meander cut-off cave, bypassing 9 mi of meandering surface channel. In addition, tributary caves were formed in response to the incision of the karst surface by Sinking Fork and show a complex history of interaction with the changing flow path and elevation of the stream. Cool Springs Cave, 17,000 ft long, is the best example of this interaction.

STALAGMITE CAP MORPHOLOGY — THE "STANDARD" STALAGMITE

Rane L. Curl

Department of Chemical Engineering, University of Michigan
Ann Arbor, Michigan 48109

The shape of an equilibrium stalagmite cap growing with first order deposition kinetics (equilibrated PCO_2 and low supersaturation) is given by

$$x = \sqrt{2}-\sqrt{2-y^2}+\tfrac{1}{2}\ln\left[\frac{(\sqrt{2}-1)(\sqrt{2-y^2}+1)}{(\sqrt{2}+1)(\sqrt{2-y^2}-1)}\right]$$

with $y = \frac{r}{R}$ and $x = \frac{z}{R}$

where z is the axial coordinate measured down from the stalagmite apex, r is the radius to the surface at z, and R is the limiting radius of the stalagmite at large z.

^{230}Th-^{234}U AGES OF SPELEOTHEMS FROM MYSTERY CAVE, MINNESOTA

Richard S. Lively
Minnesota Geological Survey, 1633 Eustis, St. Paul, Minnesota 55108
and
E. Calvin Alexander, Jr.
Minnesota Geological Survey, Minnesota Speleological Survey, and Department of Geology and Geophysics, University of Minnesota Minneapolis, Minnesota 55455

Fourteen $^{230}Th/^{234}U$ ages have been obtained for speleothems from five locations in Mystery Cave, Minnesota. The analytical data are given below:

I.D.#	Description	$^{230}Th/^{234}U$	$^{234}U/^{238}U$	$^{230}Th/^{232}Th$	Age(10^3yr BP)
MC-1	flowstone	0.110±.006	1.534±.046	16.8	12.5±0.7
MC-7	calcite crystals (base)	0.111±.004	1.380±.025	5.3	12.6±0.4*
MC-8	calcite crystals (mid)	0.087±.004	1.407±.018	11.8	9.8±0.5*
MC-9	calcite crystals (top)	0.071±.004	1.495±.028	11.5	8.0±0.4*
MC-3	stalagmite (base)	1.272±.047	2.677±.127	133	8.0±0.4*
MC-3	stalagmite (top)	0.754±.038	2.542±.144	18.7	126±10
MC-4	stalagmite (base)	0.854±.039	1.975±.108	53.6	163±14
MC-4	stalagmite (top)	0.743±.027	2.151±.082	77	125±8
MC-6	flowstone	0.854±.028	2.101±.085	31	161±10
MC-5	flowstone	0.636±.036	2.603±.109	>1000	97± 8
MC-18	rimstone	0.698±.019	1.285±.019	177	122± 6
MC-11	drapery (inner)	0.763±.024	1.309±.037	126	143± 9
MC-11	drapery (outer)	0.737±.018	1.477±.022	40.5	131± 6
MC-16	flowstone	0.782±.028	1.473±.011	224	146±10

**corrected for detrital ^{230}Th assuming $(^{230}Th/^{232}Th)_{detr.} = 1$*
***sample undatable due to apparent migration of U isotopes.*

Sample MC-1 caps a gravel deposit along the commercial tour in Mystery II. Samples MC-7 through 9 are from a 50-cm-thick crudely laminated aggregate of coarsely crystalline calcite which caps a gravel deposit near the Bomb Shelter in Mystery I. Samples MC-3 through 6 are from the west end of 5th Avenue near Dragon's Jaw Lake. Sample MC-18 is from the west portion of 4th Avenue. Samples MC-11 and 16 are from Enigma Pit.

These data identify two periods of speleothem deposition in Mystery Cave—the present back to ~13,000 BP and ~120,000 BP to ~160,000 BP— which we tentatively associate with interglacial periods.

THE CROLL AS A KNEE CAM

Kirk MacGregor
78 King High Avenue, Downsview, Ontario, Canada M3H 3B1

While the Croll ascender, manufactured by Petzl in France, is specifically designed as a torso ascender for frog systems, its small size, light weight, convenient shape, and fast operation make it an obvious candidate for use as a Gibbs system knee cam. Experience with an unmodified Croll simply incorporated into a Gibbs system indicates that this is workable, but that good performance can be achieved only by making some simple modifications. When modified, notably by correction of a design deficiency in its cam, the Croll makes an excellent Gibbs knee cam.

United States/Wyoming—One of the largest continuing projects ever supported by EARTHWATCH, Dr. B. Miles Gilbert's excavation of a large vertical cavern near the Big Horn Mountains in Wyoming has employed 15 teams (numbering 154 volunteers) over six consecutive years. The cavern acted for many millennia as a "natural trap": a 65-foot shaft invisible on the surface to animals on the run, who blundered into it and died. Thus it forms a perfect site for paleontological excavation. Among the mammals that have been found at the bottom of the shaft are mammoth, bear, dire wolf, camel, antelope, three kinds of *Equus*, and even the muskox, otherwise extremely scarce in Pleistocene sites. Volunteers, who daily entered the cavern by rappelling or climbing down a scaffolding erected for the purpose, contributed thousands of hours to the research effort.

SHELLY MENOLASCINO

Daylight shimmers down into the 65-foot "Natural Trap" where EARTHWATCH volunteers have excavated for bones of Pleistocene animals.

THE SOUTHEAST MINNESOTA KARST PROJECT

E. Calvin Alexander, Jr., George H. Shaw, and
R. Venkatakrishnan
Minnesota Geological Survey, Minnesota Speleological Survey, and Dept. of Geology and Geophysics, Univ. of Minnesota Minneapolis, Minnesota 55455
and
Ronald C. Spong
1772 Ashland Ave., St. Paul, Minnesota 55104

An extensive karst has developed in Lower Paleozoic Carbonates in the southeastern corner of Minnesota. Recognition of pollution and water supply problems, accentuated by the 1976 drought, has led to initiation of a state funded study of the area. The project is organized on scales ranging from regional (~40,000 km^2) to very local (single cave systems). Studies to date include the following:

1. Compilation of a karst features data base (sinks, springs, etc.) and a regional map of the density of karst features.
2. Analysis of the variation of joint patterns in the region, eventually to be related to hydrologic development.
3. Geologic and karst features mapping of four contiguous 7½' quadrangles centered on the largest cave system in the region to serve as guide.
4. Stream tracing studies in the four-quadrangle area using soluble dyes and dyed lycopodium spores.
5. Periodic *in situ* water chemistry measurements and sampling to provide "background" values and locate chemical anomalies, if any.
6. Mapping of the Mystery Cave System, currently at 16.7 km and going.
7. Studies in Mystery Cave (including 4 and 5 above), sedimentologic studies of cave sediments and geochronological studies using disequilibrium U-Th methods.

VERTICAL

(Author unknown)

Vertical caving has often been referred to as "mountain climbing underground." Considering the differences that exist between caving and climbing this is, perhaps, not the best of analogies. To be sure, modern vertical caving techniques have developed as an outgrowth of technical mountaineering, but the gap between caving and climbing has become so large that the only similarity between the two is their common goal of developing methods by which vertical faces can be conquered dependably, rapidly, easily, and safely.

While mountain climbers can generally see their objective, cavers cannot. For this reason, vertical cave exploration often takes place in surges and retreats instead of in one massive assault. Equipment requirements may be unknown, placing an even stronger emphasis on light-weight, multiple-purpose devices. The "gentleman-sport" attitude of climbers is all but lost on cave explorers, whose only value in climbing techniques is to attain a position from which the cave may be "pushed" further; climbing is a means to an end, not the "end" itself. Too, cavers tend to descend before they ascend; this relieves them of the hazards of aid-climbing.

For these reasons, and many others, the science of vertical caving has diverged from its parent, technical climbing.

KARST WATER TRACING IN FILLMORE COUNTY, MINNESOTA

Ronald C. Spong
1772 Ashland Ave., St. Paul, Minnesota 55104
and
E. Calvin Alexander, Jr., George H. Shaw, and
R. Venkatakrishnan
Minnesota Geological Survey, Minnesota Speleological Survey, and Dept. of Geology and Geophysics, Univ. of Minnesota, Minneapolis, Minnesota 55455

In Fillmore County, Minnesota the upper Ordovician Maquoketa, Dubuque and Galena formations form an important shallow, carbonate aquifer.

Although the regional dip is gently to the southwest, area surface streams flow east toward the baselevel Mississippi River. This aquifer is perched above deeper aquifers on the impervious Decorah Shale Formation. Deteriorating water quality and episodes of contamination in the shallow aquifer provided the impetus for our state-funded study to delineate the karst water regimes in the area.

We have utilized sodium fluorescein, rhodamine B, rhodamine WT, dyed Lycopidium spores and sodium chloride to establish ~35 karst water interconnections. The subsurface watersheds defined by our tracing often bear little resemblence to the overlying surface watersheds. Generally, however karst water drainage mimics eastward surface water drainage.

Water from several different surface sink points may converge at a single spring. Distributary patterns, in which water from one surface sink appears in several, widely separated springs also occur. The latter pattern disperses pollutants from one surface drainage basin into two or more subsurface basins—greatly complicating control measures in the event of a major pollution event.

PROFILE OF LEADERS OF NSS INTERNAL ORGANIZATIONS

Evelyn W. Bradshaw,

1732 Byron, Alexandria, Virginia 22303

A questionnaire was sent to 207 NSS members identified on 1978 annual Internal Organization reports as Chairmen or Vice-Chairmen (or the equivalent) of NSS grottoes or regions. My purpose was to learn something of the backgrounds of these individuals and, coincidentally, whether any significant differences emerged between male and female leaders.

The most significant difference noted was that regarding residence. Only one-fifth of the women respondents had lived in the same state for the past 10 years, as compared to half of the men. Three-quarters of the men reported more than 10 caving trips in 1978; less than half of the women participated that often. To be significant, this needs to be correlated with current residence. One-third of the women mentioned leadership experience in non-caving groups, as compared to 29% of the men. One-fourth of the men with non-caving leadership included some responsibility with Boy Scouts as part of this experience.

The percentages of men and of women who have led youth groups caving and who have caved as part of youth groups were similar. About one-third of each sex had not attended a national convention; a lower percentage had not been to a regional meeting. Most leaders were in the 25 to 35 age range.

A number of interesting comments were made by respondents, and the results may raise as many questions as they answer. The questionnaire should be submitted to some non-leaders, to determine whether we have a profile of an NSS leader or one of the typical NSS member.

Hidden Cave

Staging Area: Reno, Nevada

Discipline: Archaeology

The history of archaeology is filled with accounts of dramatic and exciting discoveries. The eyes of the world turned to Egypt as Carter's lantern lit up the glittering treasures of King Tutankhamen's tomb. Archaeologists and laypeople were surprised by Schliemann's unearthing of Troy, the Greek Bronze Age city immortalized by Homer.

Dr. David Thomas, Curator and Chairman of the Department of Anthropology at the American Museum of Natural History in New York, is a specialist in the prehistory of the American Southwest.

Yet equally important finds made by archaeologists never reach the headlines. One example is a Nevada cave, sealed by natural causes over 4,000 years ago. When archaeologists entered, they found intact the sandals, basketry, cordage and wooden tools as they had been left so long ago by prehistoric Americans.

By 1979, scientists excavating this "Hidden Cave" to a level of volcanic ash revealed well-preserved extinct horse and camel remains as well as many human artifacts.

Dr. David Thomas, curator and chairman of the American Museum of Natural History's Department of Anthropology, has conducted excavations in numerous environmental settings inhabited by prehistoric man. Finds from Hidden Cave will add a dimension to the Natural History Museum's long-term program aimed at reconstructing how early man adapted to his western desert home.

The goal of this expedition is to help complete the excavation of Hidden Cave. Good physical shape is a necessity, for entry into the cave is on all fours. The artifacts—fossils, remains of shell beads and incised bones and botanical samples must be gently removed from the ash and transferred out of the cave. After being screened and washed, specimens will be labeled and analyzed at the field lab or forwarded to the appropriate specialist.

Field conditions: Hidden Cave, located just east of present-day Fallon, Nevada, is at 4300 feet, a desert where temperatures often climb to 110°F. Volunteers will pitch tents and share cooking and cleaning duties at the base camp situated close to the site and to town. A community swimming pool will provide volunteers with a place to cool off after a day's dig. Attending daily classroom staff lectures on archaeological theory, while deeply involved in its practice, will make this expedition a rich learning experience.

Team: Jul 7-25

Share of costs: $850

EARTHWATCH

Box 127 10 Juniper Road Belmont, Massachusetts 02178

National Speleological Society
Cave Avenue
Huntsville, Alabama 35810

Address Correction Requested

12386 R 0780 NSS 4
HORTON H. HOBBS, III
601 WHITE OAK DR.
SPRINGFIELD, OH 45504