SELECTED ABSTRACTS FROM THE 1995 NATIONAL SPELEOLOGICAL SOCIETY NATIONAL CONVENTION IN BLACKSBURG, VIRGINIA

ARCHAEOLOGY SYMPOSIUM ON CAVE ARCHAEOLOGY IN AND AROUND VIRGINIA

Caves and Culture: Human Use of Cave Resources Within the Context of Virginia

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The human utilization of caves within the Commonwealth of Virginia began early in prehistoric times and has extended to the present. Such use often has focused on the exploitation of removable resources. Knappable lithic materials for the production of stone tools are an important prehistoric example. During historic times, the mining of saltpeter dominates although other natural resources also were removed.

The human interaction with caves, however, extends well beyond raw material extraction into the realm of ceremonialism and supernaturalism. Within a Virginia context, Native American uses of caves include both human interments and the codification of symbols. Cave burials have long been known and appear to include attitudes of elaborate ceremonialism as well as less intricate body disposal systems. The mud glyph cave phenomenon has been recorded in Virginia with incised designs and anthropomorphic figures apparently mediating between the sacred and the mundane. Such symbols have roles in rites of passage.

Historic use is usually framed in a more functional light. While resource extraction is an obvious utilization realm, the historic use of caves for other purposes is prevalent and includes resort recreation, scientific study, aesthetics, and general exploration.

The Skeletal Biology of Individuals From Late Prehistoric Mortuary Caves in Western Virginia and East Tennessee

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Over the past four years, extensive and, in some cases, intensive investigations have been conducted of prehistoric Native American mortuary caves in east Tennessee and southwestern Virginia. At least some of these sites appear to date to ~1000 to 500 years ago and some contain the remains of several individuals.

Four Thousand Years of Native American Caving in the Southern Appalachians

Charles H. Faulkner, Department of Anthropology, University of Tennessee

Since the seminal work of archaeologists in Mammoth and Salts Caves, Kentucky in the 1960s, it has been known that prehistoric Native Americans not only buried their dead in these caverns, but also intensively explored and mined this "dark zone" at least 4,000 years ago. When the glyph caves of Tennessee and Virginia were studied in the 1980s, these underground sanctuaries were found to be the scene of non-mortuary ritual as well. It was concluded at that time that Native American cave use over the past 4,000 years may have shifted from exploration to intensive mining of minerals until about the beginning of the common era. At that time, the increasing use of caves as burial places eventually led to their abandonment as sources for minerals, and by ca. 1,000 years ago only a few of these caves continued to be used for ceremonial purposes. The recent discovery of two additional glyph caves in Tennessee, one in Virginia, and two in Kentucky has resulted in a reassessment of this chronological sequence of prehistoric cave use. It also serves notice to modern cavers that the caves of our region still contain important undiscovered archaeological remains.

Integrating Protection and Interpretation of Fragile Cave Archaeological Resources: A Case Example From Crumps Cave, Kentucky

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Since 1989, Crumps Cave (15Wa6), in the karst-rich region of south-central Kentucky that includes the Mammoth Cave system, has been the focus of archaeological research, specifically on the prehistoric Native American mud glyphs that cover hundreds of square meters deep within the cave. One aspect of this project has been the construction of what is claimed to be the second largest cave gate in the world to protect the cave from further vandalism, while at the same time allowing passage of fauna, including at least two species of endangered bats. In 1994, a video news feature, *Saving a Kentucky Time Capsule*, was produced on the archaeology of the cave and the endeavors to protect it. This feature ran continuously at the Kentucky State Fair, and aired a number of times on the Kentucky Educational Network (public television station). In this manner, close to a million viewers were reached about this important resource. An hour long national production is now planned. In this paper, I present a summary of the archaeology of Crumps Cave (vestibule and mud glyphs) and the effect of the video documentation for technical purposes and interpreting this fragile cultural resource.

Virginia Burial Caves: An Inventory of a Desecrated Resource

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In an ongoing inventory of Virginia cave resources, 23 burial caves have been field documented by the Marginella Burial Cave Project (MBCP). All but one site had been vandalized to varying degrees. In addition to the burial resource inventory, goals of the

MBCP include site protection and education. Two sites in Lee County and one in the town of Radford have been protected by gates and are chosen for discussion. All three cave sites displayed evidence of recent causal disturbance. Indian Burial Cave was known locally as a burial cave and has suffered desecration for decades. Looting of this site continued after it was initially inventoried, prompting gating. Bone Cave also was known locally as a burial site, although locals thought the burials were of black slaves. Apparently, disturbance to this site was minimal and largely surficial. Bone Cave was scheduled for destruction by a road building project until the MBCP and subsequent inventories revealed its significance as a Native American burial site. Adams Cave had been mined historically for saltpeter and had a long history of casual disturbance by high school and college students. Both the historic and the prehistoric significance of this cave had escaped recognition by the caving and science communities until a student brought a mandible and two long bone fragments to a college professor. Disturbed and exposed human skeletal components were removed, under permits, from all three sites for analysis and study.

Stable Isotope Analysis: A Tool For Cave Archaeology

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To more fully understand a past civilization, knowledge about its subsistence strategy is necessary. Traditional methods of diet determination focus on an incomplete and misleading archaeological record of faunal and floral remains, artifacts, or other cultural evidence associated with a site to provide information on available food resources, procurement strategies, and processing methods. However, population mobility and differential artifact preservation make quantification of the relative inputs of foods difficult. Ethnohistoric accounts generate a general outline of potential food items and their relative importance, but such accounts are usually biased by the observer and present an idealized view of past cultures. Observations of dental attrition, caries, and general health provide information about what may have been consumed. Unlike other lines of evidence, the stable isotopes of carbon and nitrogen in human bone reflect the chemistry of the diet and, therefore, provide a direct measure of the foods consumed. Stable isotope analysis of human remains is an especially valuable research tool in archaeological sites where other dietary evidence may be missing or out of context.

Science Versus Grave Desecration: The Saga of Lake Hole Cave

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In the spring of 1990, a prehistoric burial site in a small cave in Cherokee National Forest, Johnson County, Tennessee was almost completely destroyed by artifact collectors. Archaeological research of the disturbed deposits, conducted with the consent of the Eastern Band of Cherokee, yielded thousands of human skeletal remains, faunal remains, and artifacts. There may be hundreds of similar sites yet undiscovered in limestone and dolomite formations of the Southern Appalachian region. Efforts should be made by federal and state agencies to discover cave sites and to protect them, as they are considered by the American natives to be sacred places.

BIOLOGY SESSION

A Report on the Cave Diplura of Virginia

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An examination of 87 collections of diplurans from 65 caves in Virginia has revealed the following: one new undescribed species of *Mixojapyx*, family Japygidae, from a cave in Rockingham County; and at least six species of *Litocampa*, family Campodeidae, from the other caves in 12 counties in the southwestern part of the state. The *Litocampa* species in Virginia represent portions of three larger species groups. The most primitive species group and the most advanced species group are represented by two species each. The intermediate species group is represented by at least two species, although differences in the lengths of macrochaetae and body size of individuals of some cave populations suggest that there may be more. Cellulose acetate gel electrophoresis is being used in an attempt to help decide if these observed morphological variations represent specific or subspecific differences.

Overview of the Nature Conservancy's Cave Protection Program and Future Inventory Needs

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The Nature Conservancy has a national mission to find, protect, and maintain natural biodiversity. In some states, much of this biodiversity is in caves. Stewardship staff within The Nature Conservancy of West Virginia conducted a national survey of Conservancy offices to determine the degree of protection that the Conservancy has offered to significant bat and invertebrate caves. Cave protection is a high priority in some states but can be increased. Many cave-rich states lack a link to the cave biology community to either identify or inventory potentially significant caves. In some states, bat protection is the priority with little attention given to invertebrates. Cave community classification has only begun in one or two states. The Conservancy would like to work more closely with the cave biology community to increase inventory and classification information.

An Ecological Assessment of Harrisons Cave Barbados, West Indies

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From 24 July to 01 August 1994, ecological investigations were carried out in Harrsions Cave, St. Thomas, Barbados, West Indies. Biological and physicochemical data were gathered in representative sections of the cave, with special attention directed to the stream(s) of the cave. Traps were placed in drip pools, pool and riffle sections of the streams, and in various terrestrial sites. Much effort was made in the commercial sections but undeveloped areas of the cave also were sampled.

Observations and raw data indicate that Harrisons Cave is impacted heavily by the totality of activity associated with the tour operation of the cave as well as from runoff from varied land uses, including areas in the environs of Welshman Hall, Allen View, and Welshmans Gully. Although no data are available for the cave prior to its devel-

opment, the presence of terrestrial and aquatic fauna in the undeveloped Natural Entrance section and their near absence in the tour sections suggest that the commercialization process has resulted in the extirpation of biota from much of the cave. A particularly obvious problem is associated with the erosion of rubber from tires of tour trams along the tourist route. This results in a "black stream," a true eye-sore in an otherwise crystalline white and tan environment, and the benthic habitat is adversely impacted. No aquatic fauna were found in any sections of the stream in the developed portions of the cave. A single organism (a nereid polychaete *Namalycastis* sp.) was found in fine sediments of isolated drip pools and only a few species of terrestrial organisms were noted. The main stream below Cascade Pool is severely impacted by "rubber-calcite" deposition. Numerous recommendations have been made to the government of Barbados to resolve the many historical and current anthropogenic impacts.

New Data on the Invertebrate Cave Fauna of Virginia

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During a five-year period between 1990 and 1994, macroscopic invertebrate animals were collected and identified from 141 limestone caves in 22 counties in the Appalachian Valley and Ridge and from a copper mine and railroad tunnel in the adjacent Blue Ridge Mountains of western Virginia. Ninety-seven of the caves were biologically sampled for the first time. Approximately 100 different species were collected and identified, approximately 50 of which are troglobites. Taxonomic groups represented in the samples included snails, copepods, amphipods, isopods, millipedes, centipedes, harvestmen, pseudoscorpions, spiders, symphylans, diplurans, collembolans, dipterans, and beetles. The samples include 18 to 22 new (undescribed) troglobitic species, the majority of which are amphipods (*Stygobromus*), pseudoscorpions (*Kleptochtonius*), and beetles (*Pseudanophthalmus*). However, a significant number of new, non-troglobitic species were also included. Aside from the discovery of new species, important new records were established for described species, some of which were either very poorly known or believed extremely rare (such as some species of snails, amphipods, isopods and carabid beetles).

An important result from this study is that even karst regions which have been studied biologically for many years, such as in Virginia, there exist numerous biologically unsampled caves harboring undescribed species or previously unrecorded populations of described species. Similarly, even previously studied caves may have undiscovered new species or unrecorded populations of described species that may be revealed by systematic searching on repeated visits.

Mark-Recapture Estimation of the Population Size of *Stygobromus emarginatus* in a Stream in Organ Cave

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The population size of the troglobitic amphipod, *Stygobromus emarginatus*, in the Sively #2 stream in Organ Cave was estimated using the mark-recapture method. We sampled three sites in the stream channel in the lower half of the stream, and three sites of mud-bottomed pools adjacent to the channel in the upper half of the stream. Recapture rates ranged from 20 to 50 percent in the stream sites, but ranged from only zero to three percent in the pool sites. Estimated population densities ranged from 10 to 30 per m^2 in the stream sites, and showed clear but not statistically significant differences among sites and over time. Estimated population densities ranged from 250 to 300 per m2 in the pools sites, but the standard errors were large due to the low recapture rates. Spatial and temporal fluctuations in population densities at the pool sites are also evident.

Primitive Metabolism in Archaic Hydrothermal Lava Caves

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The microspace and macrospaces from basaltic lava, invaded by hot reduced water, represented a redox environment called here Hydrothermal Lava Cave (HLC). HLC is proposed as a good environment for a primeval chemolithotrophic metabolism. The redox interfaces from HLC (water/gas, water/mineral surfaces, water/water) were more stable in space and time than redox interfaces in deep sea vents, and hydrolysis was lower due to the subaerial and aphotic conditions. Recent studies suggest a thermal anaerobe progenote, related with sulfur. The proposed reactions are :

$7H_2S + FeS + 4HCO_3^- + 2H^+ = (CH_2\text{-}COO^-)_2 + 7FeS_2 + 8H_2O$

$7H_2S + 7FeS + 4CO_2 = (CH_2\text{-}COOH)_2 + 7FeS_2 + 4H_2O$

($G° = -420$ kJ/mol).

The redox catalysis was facilitated by two categories of peptides (some enriched in Arginine and some with iron-sulfur clusters) with a plausible existence in basalt microspace. Proton transport across membranes was coupled with a secondary phosphorylation on the oxidated side. Secondary phosphorylation and condensations of activated monomers occurred inside protocells. The mechanism is proposed as a primeval negentropic biological activity because the increase of the half life of the internal oligomers was dependent on energy derived from an exergonic process (a redox reaction).

Distribution of the Ellett Valley Millipede *Pseudotremia cavernarum* Cope, in Virginia

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Pseudotremia cavernarum, the Ellett Valley Millipede, has only been found in caves in Ellett Valley, Montgomery County, Virginia. This troglobitic millipede is currently considered a threatened species in Virginia. When this millipede was described, it was known only from Erhart Cave. Erhart Cave was destroyed in the 1970s by quarrying. In recent surveys, the millipede was found in one new cave (Unnamed Cave A) and one previously reported cave (Daves Cave). Based on all cave records, *P. cavernarum* is restricted to four caves (Aunt Nellies Hole, Daves Cave, Heartbeat Cave, and Unnamed Cave A) near the former location of Erhart Cave. In recent surveys *P. cavernarum* was found from May to July, but individuals were more comon in May. This millipede apparently emerges in early spring for mating. All specimens were found on damp organic material, usually wood. Damp organic debris may be an important food source for P.*cavernarum*. Although the species probably has a small geographic distribution, lack of intensive field sampling has certainly led to underestimation of both the range of the species and the number of caves harboring populations of *P. cavernarum*.

CAVE RESCUE SESSION

Using Gin Poles to Help Eliminate Edge Problems in Raising and Lowering Systems

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Rappelling, ascending, raising and lowering of litters and equipment are a problem at the edge of a cliff, building, or pit. The anchors and haul systems are normally at the same level as the lip, and the rope forms a right angle between the load and the anchors, developing stress and friction. The ideal attachment and/or final change of direction in a system, could be 6 or more feet above and a few inches beyond the edge. The rope does not make contact with the edge or the face, thus eliminating friction and need for rope pads. The object is to create a point, increasing the angle formed by the rope to be greater than 900 and equal to or less than 1800 at the edge. This helps overcome problems and dangers associated with edge work. Raising or lower will be safer, quicker, and easier for you, your team, and your patient. You may do this efficiently, safely, and with materials commonly available at wilderness sites that are not necessarily carried with you.

There are a variety of prefab gins and gin pole arrangements for you to buy. They have various configurations, attachment points, and work well for the normal fire/rescue environment. Few, if any will provide you with the tailored, cut-to-length fit that will be required in wilderness or cave rescues. Examples of gins and gin poles can be found at the local blacksmith shop.

Specialty Cave Rescue Equipment - A Field Report

Butch Feldhaus, 614 N Valley Dr., Chattanooga, TN 37415

The RES-Q-AIRS Model HT 1000 Inhalate Delivery System and the Germa® Patient Immobilization Mattress have been used with great success by the Chattanooga-Hamilton County (TN) Rescue Service Cave\Cliff Unit.

The RES-Q-AIR® Model HT 1000 Inhalate Delivery System provides the hypothermia patient with warm (410C) saturated air (or air supplemented with oxygen) via face mask. This device was developed, and used successfully, as a tool to reverse the hypothermia which is a result of oil rig workers falling in the icy sea waters. It has made the transition to cave rescue very well.

The Germa® Patient Immobilization Mattress is a body-size vacuum split which has been used successfully in conjuncfion with the Femo® and SKED® litters. This mattress provides full-body spinal immobilization in the position of injury. It is very comfortable in that it conforms to the patients body unlike hardwood backboards, etc.

To Train the Trainer

Jack T. Grandey, NREMT-P, ER/NCRC Supervisory Instructor, 862 N Beechwood St., Phiadelphia, PA 19130-1437

Three years ago, the Eastern Region of the National Cave Rescue Commission (ER-NCRC) initiated an instructor development program directed at both the novice and experienced instructor. The goal was to provide improved instructional performance and quality control in its cave rescue training curricula.

Key to the program was the identification and promotion of several experienced instructors to the newly created position of supervisory instructor. In addition to their regular teaching assignments, these individuals would be responsible for instructor monitoring at regular cave rescue training programs and instructing at an annual instructor refresher. Attendance at the annual refresher is mandatory for all eastern region personnel to maintain their teaching status.

The annual refresher has two tracks. For the new instructor, or those requiring skills remediation, the core content is fixed and covers principles of adult education, lesson plan development, evaluation & remediation, didactic presentation techniques, psychomotor teaching skills, and creation & use of visual aids.

Instructors with previous training receive lectures on specific areas of instructional technique that have been identified by the supervisory instructional staff and the region coordinator as a priority for the current year. Additionally, they perform mini-lessons in small groups, under the guidance of a supervisory instructor, critiquing one another and sharing instructional techniques. Lastly, the instructor staff is divided into groups according to their areas of special expertise to further work on the ER-NCRC cave rescue study guide or develop and refine audio/visual aids for specific subject areas of the cave rescue curriculum.

*Replace Your Hypothermia Thermometers with a Functioning Human Brain

Jack Hissong, 8716 Quarterhorse Dr., Indianapolis, IN 46256

Measuring and knowing the core temperature of your hypothermia patient in the cave has been important in cave rescue situations. But the necessity of getting a low reading thermometer or more sophisticated measuring and monitoring device on site has been overrated. Rectal probes have fallen into disfavor due to issues of patient tolerance, packaging, unpackaging, availability, and delays. Axillary reading have some of the same problems. We can make accurate guesses bases on signs and symptoms.

CONSERVATION / MANAGEMENT SESSION

Differential Cave Management in Two Adjoining Areas in Hawaii County, Hawaii

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The world's leading area for studies of lava tube caves lies between Mauna Loa volcano and the East Rift Zone of Kilauea volcano in Puna District, Hawaii County, HI. Here members and cooperators of the Hawaii Speleological Survey have mapped more than 65 km of caves, including the world's longest lava tube cave: Kazumura Cave, which is 47 km long at present. A housing boom is occurring over many of these caves, and the county is planning extensive infrastructure developments in the cave area.

Just across the district line in Kau District is the caldera of Kilauea volcano. In 1994 and 1995 the Hawaii Speleological Survey identified, mapped, and inventoried numerous caves in this much-visited National Park. In addition to obvious management differences inherent in land stewardship in the two areas, major differences in cave management strategies will be needed to maximize protection of cave features, resources, and values. Other examples of marked differences in features, resources, and values exist in adjoining pseudokarstic and karstic areas elsewhere in the world. Such differ-

ences strongly support the concept of cave management by individual prescription rather than management by broad categorization.

Trevor Shaw's Report on the First Spelean Cinderella "Stamps"

William R. Halliday, 6530 Cornwall Court, Nashville, Tennessee 37205

In 1994, noted speleohistorian Trevor Shaw published a definitive report on Cinderella advertising stamps, in German, of Austria's Lurgrotte cave system in a volume celebrating the Centennial of Lurgrotte. One set of these stamps was issued in 1906 and constitutes the first known spelean Cinderella "stamps." This material is part of a longer historical article on publicity for the cave. A manuscript copy exists in English, in addition to the German published text.

The Sloans Valley Cave System and The Pulaski County Landfill or Can and Should an "Open System" Be Managed?

Hilary Lambert Hopper, Sloans Valley Conservation Task Force

Popular, accessible, and challenging, the 42 km long Sloans Valley Cave System, located in southern Pulaski County, Kentucky, is a regional natural treasure. With 16 official entrances (and more rumored) on private and public lands, Sloans only protection against overuse has been its complexity, which can overwhelm even experienced cavers using the maps compiled by Louis Simpson, Dave Beiter, and other Ohio and Kentucky cavers and grottoes during the 1960s and '70s.

Adding to the challenge of protecting Sloans health is the Pulaski County Landfill, opened in 1980 on a strip mine site at the top of the cave system's drainage. By the late 1980s, cavers and landowners were concerned about the quantity and quality of sediment running off the landfill permit area, onto private property, and into at least one entrance of the Sloans Valley Cave System, which drains into Lake Cumberland, the region's water supply and recreational resource.

The Sloans Valley Conservation Task Force, NSS, was organized in 1992 with the short-term goals of ascertaining whether or not there was factual proof of a negative environmental impact of the presence of the Pulaski County Landfill on the Sloans Valley Cave System and adjacent karst features and the long-term goals of bringing management and protection to this wide-open system.

Our Task Force has worked in sublime cooperation with prominent cavers, cave scientists, NSS personnel, the Miami Valley and Dogwood City grottoes, and a Kentucky-based citizens action group, to bring about at least some measure of success in reaching both short- and long-term goals.

A Review of United States Cave Protection Laws

George N. Huppert, Department of Geography and Earth Science, University of Wisconsin - La Crosse, WI 54601

The first state cave protection act was passed in Colorado in 1883; unfortunately it was repealed in 1971. From that modest beginning there are now a total of 22 states, Puerto Rico, and the Cherokee Nation that have specific cave protection acts. Most of these have been legislated during the last 20 years. There are a number of laws on the federal level that can be used for cave protection, however this presentation will concentrate on the laws of specific states.

The World Wide Web as a Conservation Tool

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The Internet (sometimes known as the "Information SuperHighway") connects millions of computers throughout the world together into essentially instantaneous communications. The World Wide Web is a graphical hypertext interface that enables Internet users to post information, exchange e-mail, and collect information from users. To take advantage of this as a communications and educational tool, the Cave Conservation and Management Section has established a Web Home Page at http://www.halcyon.com/samara/nssccms/.

DIGGING SESSION

Digging Put the Organ Cave System Together

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Most caves of any size have grown as a result of the extra efforts of explorers. Organ Cave has grown as a result of cave diving and the use of a rope toss, but it was primarily added to and connected together by digging open blocked passages. Reports of large cave passages encountered by water and well drillers and the closeness of Fox Hole Cave, which overlays Organ, whet the diggers resolved.

GEOLOGY SESSION

Speleogenesis of a Granite Solution Cave at Forty Acre Rock, Kershaw, South Carolina

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Forty Acre Rock is approximately 15 kilometers northeast of Kershaw, South Carolina, near the transition zone between the Piedmont and the upper coastal plain. Covering fourteen acres, the rock consists of a large exposure of the Pageland Granite; a massive, coarse-textured gray granite with inclusions of fine-grained pink granite and felsitic andesite. Near the base of the steep eastern margin of the rock is a cave consisting of two ten-foot-long tunnels which slope upward into a low passage of unknown length parallel to the cliff face. Granite caves in the Lost Creek area of Colorado are reportedly the result of surface streams removing chemically weathered rock along joints. Other caves in granite are usually result from undercutting by streams, wave action, talus accumulation, or tectonic action. The cave at Forty Acre Rock, however, is apparently of true solutional origin. The tunnel roofs are scalloped, the walls smooth, and the tunnels seem to have little relationship to the joints in the granite.

The best evidence for a solutional origin to this cave lies in the existence of a readily available and highly aggressive source of water in the form of solution basins (opferkessel). The solution basins support an abundant growth of mosses, algae, grasses, sedums, and even small trees. The growth and decay of this vegetation produces carbonic and sulfuric acids which keep the water pH generally less than 5.0. Temperatures the basin waters are usually well above ambient air temperature due to solar heat on the large bare rock surfaces. This hot acidic water is flushed out of the basins with every summer afternoon

rainstorm, where it undoubtedly seeps into the granite and becomes available to dissolve cave passages.

Karst Hydrology and Geomorphology of the Barrack Zourie Cave System, Schoharie County, New York

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The Barrack Zourie Cave System represents an important karst system of the Cobleskill Plateau, east-central New York. Discovered in 1992, over five kilometers of passages have been surveyed at two distinct levels. Passages in the cave display a complex developmental history which is directly coupled with surface hydrology. The present hydrological role of the system is as a conduit for water insurging at Cave Mistake and Browns Depression, and resurging at Doc Shauls Spring after flowing through glacial material which fills a buried valley. Flow routes were proven by qualitative dye traces.

Minimum age of the system is 277 Ka, based on U/Th dates from speleothems. Fine-grained sediments found in the system are potentially stable carriers of the geomagnetic field. The system has survived and functioned through at least one glacial/interglacial cycle. Complex relationships exist between the system and the McFails and Howe systems of the plateau.

Pit Craters and Open Vertical Volcanic Conduits of Hualalai Volcano, Hawaii

William R. Halliday, Hawaii Speleological Survey of the NSS, 6530 Cornwall Court, Nashville, Tennessee 37205

Na One Pit on Hualalai Volcano, with a depth of 263 m, is the deepest pit in the United States if water-filled depths of another Hawaiian pit are excluded. It is a compound volcanic structure consisting of an open vertical volcanic conduit opening near the bottom of a pit crater. Other open vertical volcanic conduits and other pit craters exist on this volcano. The deepest pit crater observed to date is about 200 m deep. The open vertical volcanic conduits are less easily observed and studied. Another type is known only in the vent area of the Kaupulehu ultramafic xenolith nodule area. The term pit crater is not clearly defined, at least in common usage, and no consensus exists on whether some or all pit craters should be considered speleological phenomenon or even pseudokarstic.

The Hydrology and Chemistry of Coon Lake Drips, Mystery Cave, Minnesota

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Coon Lake Drips (CLD) in Mystery Cave, Minnesota, was monitored for drip rate, water temperature, conductivity (continuous data acquisition system), and ions and environmental parameters (grab samples) between February 1993 and January 1995. Drip rates ranged from winter lows of 0.25 l/hr to storm peaks of nearly 14 l/hr. In March 1993, successively warmer days resulted in diurnal snowmelt cycles. CLD drip rates became cyclic with peaks that lagged 7, 4.5, and 7.5 hours behind air temperature peaks. The snowmelt cycles were interrupted when 4.34 cm of rain melted the snowpack, resulting in widespread flooding of the Root River and Mystery Cave. CLD responded with a rise in drip rates to 6.5 l/hr, a chaotic fluctuation (2-6 l/hr), and a rise to sustained high flows (5-7.5 l/hr).

Additional storm hydrographs and fall-winter hydrograph recessions reveal a complicated hydrologic response. Recharge passes through soil and loess (6-9 m) via matrix flow and preferential flow through macropores and gopher burrows. The flow continues through a possible rudimentary subcutaneous zone and fractured bedrock to emerge as a flowstone flow on a wall about 18 m beneath the surface. Recharge ponds upflow of the drip site induced a piston flow that ejects water at CLD within 15 minutes to several days following the onset of recharge. The ejected water lacks a distinct event signal in temperature or conductivity, though seasonal signals in conductivity and other chemical parameters were observed.

Sinkhole Back-Flooding
A Localized Karst Hazard in Virginia

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A series of back-flooding sinkholes in the Front Royal area of Warren County, Virginia may represent a significant threat to potential karstland residents. A highway construction project along U.S. Highway 340 resulted in an investigation of a number of epiphreatic sinkholes that flood in response to local groundwater fluctuations. Floodwater levels of up to 13 m have been observed boiling-up in these sinkholes. The local aquifer is partially recharged by two sinking streams draining the Dickey Ridge area of the Shenandoah National Park and adjacent private property. One sinking stream flows north through the Park and sinks near the Park Entrance; the other stream sinks east of Skyline Caverns. During precipitation events, additional hydraulic head is apparently the result of surface runoff channeled from a relatively new subdivision into a sinkhole along Browntown Road. Concerns are that development in the areas containing the back-flooding sinkholes at Riverside may result in: subsidence of sinkhole fills, formation of new sinkholes, and the back-flooding of nearby currently unaffected sinkholes. An additional concern is that further development, adjacent to the affected area, will result in additional karst groundwater inputs enhancing the risk of new karst hazards including: subsidence, flooding, and groundwater pollution in this extremely active karst area.

Early Results From the Hawkins River Site
Mammoth Cave, Kentucky

Joe Meiman, Div. of Science & Resource Management, Mammoth Cave National Park Mammoth Cave, Kentucky, 42259 & Christopher G. Groves, Center for Cave & Karst Studies, Dept. of Geography & Geology, Western Kentucky University, Bowling Green, KY 42101

Hawkins River is one of the major underground streams draining (and forming) the Mammoth Cave System. Two major tributaries, the Left and Right Forks of Hawkins River, converge within the Proctor Cave section of the system, and the waters then flow on to eventually emerge at Turnhole Spring on the Green River. A continuous, long-term water monitoring program is currently underway to understand storm- and seasonal-scale changes in water chemistry through two 140 m deep wells, one in each fork of the river a short distance upstream from their confluence. Continuously measured variables include stage height, velocity, temperature, and specific conductance,

and complete, short interval water chemistry measurements made during storms of varying magnitudes.

Because the rivers are draining large catchments, much of which lie outside of Mammoth Cave National Park, contaminants pose a threat to the sensitive ecosystem within the cave system. One of the purposes of the project is to evaluate the nature of that impact. The entire area draining to the study site is within a United Nations International Biosphere Reserve. Understanding storm-scale variations in water quality will also provide information on the physical nature of the flow system, as well as aiding the development of strategies for the effective monitoring of karst aquifers in general.

Another major emphasis involves measurement of parameters that describe the behavior of the carbonate system and the nature of the limestone dissolution process. This helps us to understand cave forming processes, as well as to field test dissolution kinetics rate laws, which are an essential component of models describing evolution of karst landscapes and flow systems.

Government Programs and the Regulation of Dye Tracing: The Future

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Due to an increasing use of groundwater tracers in the environmental business, government regulators have become concerned with the potential of cross contamination of traces that could lead to false positives, and also with the qualifications of those conducting the work. As a result, some of the states containing significant karst areas are requiring "registration" before conducting a groundwater trace. In Tennessee, this is handled through the Underground Injection Control Program. In Kentucky, you must notify the Division of Water. The Department of Natural Resources in Missouri requires a groundwater professional to become a "Registered Dye Tracing Expert." Arkansas requires that a study plan be prepared and submitted to the Department of Pollution Control and Ecology before conducting a trace. Virginia's Department of Environmental Quality presently considers the use of groundwater tracers degradation of water quality, but state agencies and consultants solving pollution problems are using groundwater tracers. In four other states surveyed, there is no official registration or regulation of groundwater tracing. Since all states consider the discoloration of water an offense, prudence dictates that cavers, consultants, and local environmental field offices should be well informed before conducting a dye trace.

An Examination of Short-Term Variations in Water Quality At a Karst Spring in Kentucky: How To Accurately Determine the Water Quality of a Karst Conduit Flow System

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Water quality at many karst springs undergoes very high amplitude but relatively brief degradation following influxes of runoff. Accurately recording transient variations requires more rigorous sampling strategies than traditional methods. A pilot study to determine the usefulness of high-frequency, flow-dependent sampling strategies, combined with coincidental quantitative dye tracer tests, was implemented in the Big Spring Groundwater Basin in Mammoth Cave National Park.

Data recorded following two separate runoff events showed that the concentrations of two nonpoint source pollutants, fecal coliform bacteria and suspended sediment, greatly exceeded pre-runoff event values for very short periods of time. A phreatic conduit segment (calculated at 17 million liters in volume) instantaneously propagated head changes, caused by direct runoff entering the aquifer, from groundwater inputs to Big Spring. The results were a significant delay between the initial increases in discharge and the arrival of direct runoff at Big Spring. The delay showed that even by sampling a karst spring only during peak discharge would be an unreliable sampling method.

Runoff from two different subcatchments was tagged with tracer dye and the timing of the passage of the resultant dye clouds through Big Spring were compared to water quality variations. Distinct lag times between the arrival of direct runoff at Big Spring and the bacteria and suspended sediment waveforms were shown through the concurrent quantitative tracer tests to be related to the areal distribution of land-cover type within the basin.

The Occurrence of Caves on the Cumberland Plateau Escarpment of Kentucky, Tennessee, Georgia, and Alabama

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The Cumberland Plateau Escarpment is a persistent topographic feature which separates the Cumberland Plateau from the Interior Lowlands (to the west) and the Valley and Ridge (to the east). Its relief ranges from about 100 to over 300 meters. Thousands of caves are known in the Escarpment, and it is host to many of the long caves of the eastern U.S. The occurrence and form of the caves is strongly controlled by stress release fracturing. Caves form within the walls of the Escarpment, and rarely penetrate beneath the caprock of the Plateau.

The longest caves form parallel to the valley walls of coves which are incised into the Plateau. These "Cumberland Style" caves are characterized by broad, sinuous trunk passages which are developed on distinct levels. The trunks represent former (or active) drainage routes for the entire flow of the basin, and are usually developed on the down-dip side of the valley. Shorter caves form directly on the face of the Escarpment. These include many contact caves, and pits, and some multi-drop systems. All show a stronger control by stratigraphy and have a more limited hydrologic function then the Cumberland Style caves.

The occurrence of caves in other escarpment settings is similar. Caves from New York, West Virginia, and Arizona all show common features, particularly parallelism of the cave with the escarpment.

Improving Fluorescent Dye Tracing Through Enhanced Dye Recovery From Passive Activated Charcoal Receptors: Discussion of Two Experiments and Results

Mark Turner, 4601 Packard Dr. Apt L-133, Nashville, TN 37211-1212

Methods of detection of fluorescent dyes employed in karst hydrologic tracing have greatly improved over the past thirty years. However, the recovery methods used in extracting dye from activated charcoal detectors have remained fairly static since the 1970s. The author has performed a series of experiments to improve recovery of

dye from activated charcoal detectors. The critical areas of concern identified are: preparing the detector for extraction, volume of eluent to weight of charcoal ratio and choice of eluent for recovery of various dyes. Results suggest that detectors should be air dried after collection and washing; that of the volume to weight ratios tested, a 10:1 ratio yielded best stable peak fluorescence for Rhodamine WT, limiting read- sorption of the dye and that Smart Solution and a propanol-based sodium carbonate eluent (Turner-1 Solution) were the superior dye extraction agents for the recovery of both Fluorescein and Rhodamine WT, of those eluents tested, from activated charcoal.

A Reexamination of Geochemical Karst Denudation Calculation and Validation By Stream Incision Rates

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Several methods are used to calculate denudation rates in karst areas. Two primary techniques involve calculations based on measured chemistry of spring discharge and on theoretical expression of carbonate dissolution. Significant variation in results occur where nonspring-based calculations include denudation by surface runoff that does not enter the aquifer. For comparable results, equations must be adjusted to reflect differences in recharge versus runoff. Denudation equations can also be combined to estimate the size of spring drainage basins using measured water hardness and denudation as calculated by methods not relying on known basin size.

Denudation calculations adjusted for recharge-runoff differences and the calculations of drainage basin areas were validated by application to the Lower Glen Rose Aquifer in south-central Texas. Relict geomorphic features were used to estimate denudation by calculating the differences in elevation versus their known age. This method was used in interstream areas and was especially useful in streams. However, adjustments were necessary for a major knickpoint migration through the drainage network. In the Lower Glen Rose Aquifer, denudation was geochemically calculated at 21-24 mm/Ka and at 25 mm/Ka based on the incision rate of the Guadalupe River. Use of these rates to determine the age of aquifer and cave development favorably compares with ages derived from speleothem dating, paleontological material, and paleoclimatic changes. Similarly favorable comparisons occur between the potentiometrically derived size of the aquifer's Honey Creek Cave drainage basin with the size calculated from denudation rates.

The Meteorology of Harrisons Cave, Barbados, West Indies

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During the period 24 July through 01 August 1994, a team of speleologists from the United States, representing the National Speleological Foundation, conducted studies in Harrisons Cave, Barbados, West Indies. Barbados is a small island in the Caribbean Sea about 2500 km (1550 miles) southeast of Miami, just north of Venezuela. The center of the island is near 59.5° west longitude and 13.0° north latitude. The climate of Barbados is mild, breezy, and sunny year-round, with an average surface temperature of about 27°C (80°F). Harrisons Cave, a show cave owned and operated by the government of Barbados, is located near the center of the island at an elevation of approximately 250 meters (820 feet) msl.

Seven sets of temperature, partial pressure (due to water vapor), and relative humidity measurements (64 measurements in total) were obtained at eight locations within the cave and one location on the surface, allowing spatial variations to be studied. The measurements were clustered at near-noon and near-midnight, allowing temporal variations to also be explored. Statistics of the measurements, shown in the table below, indicate that the cave environment is remarkably constant.

The detailed data show that diurnal variations are minimal; however, variations with elevation and distance from entrances are detectable. What appears at first glance to be a variation with elevation in the cave (higher temperatures occurring at higher elevations) turns out to be caused mainly by cave air flowing over bodies of cooler water. Clouds form in the entrance passage.

GROUP	# OF MEASUREMENTS	TEMP.	PARTIAL PRESSURE	RELATIVE HUMIDITY
In-Cave + Surface	64	78.3 ±0.9°F 27.5 ±0.5°C	0.947 ±0.042 in Hg 24.1 ±1.1 mm Hg	98.1 ±3.0%
In-Cave	55	78.4 ±0.3°F 25.8 ±0.2°C	0.962 ±0.007 in Hg 24.4 ±0.2 mm Hg	99.1 ±0.5%
Deep Cave	48	78.4 ±0.3°F 25.8 ±0.2°C	0.962 ±0.007 in Hg 24.4 ±0.2 mm Hg	99.1 ±0.5%
mean error		±0.1°F ±0.06°C	±0.004 in Hg ±0.1 mm Hg	±0.5%

The Ellenville (NY) Crevice Geomorphic Processes Acting on Structural and Stratigraphic Features

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Crevices are found in the massive sandstone/ quartzite beds throughout the Appalachian Mountains. The Ellenville Crevice complex, developed in the lower member of the Shawangunk Formation, is unusual in magnitude and development. Most crevices are a few meters in vertical extent and a few tens of meters long; the Ellenville Crevice complex contains several segments which are hundreds of meters long and tens of meters in vertical extent. The other crevices have developed by the opening of prominent regional joints as rock cities located a few tens of meters from an escarpment; the Ellenville Crevice complex has no escarpment directly associated with it, and has not developed along any regional joint set. A large block slide, slipping on the surface of underlying shales, has several crevice-type openings near its upper edge, some of which are roofed by differential slip within the main block or breakdown from the crevice edge which is wedged lower in the opening. A similar, but somewhat larger block slide just to the south of the area containing the crevice complex has been mostly removed by subsequent erosion. Geomorphic indications are that the slides occurred during the last Late Wisconsin glacial events. Different thicknesses of tills indicate that the southern slide was the earlier one, and probably occurred before the last ice advance, and the block forming the crevice complex began moving near the end of the last ice advance, probably when the ice sheet began melting which provided water for lubrication of the underlying shale surface as well as hydraulic push to help move the block.

GEOLOGY SPECIAL SESSION: KARSTMAP

Introduction to the Special Session

William B. White, Department of Geosciences and Materials Research Laboratory, The Pennsylvania State University, University Park, PA 16802

While more caves have been mapped in the U.S. than in any other country, maps defining its karst areas are incomplete, inadequate, and sometimes inaccurate. KARSTMAP is a project of the Section of Cave Geology and Geography, and its purpose is to produce detailed and high quality maps that delineate our nation's karst.

Selected Karst Features Mapping in Virginia

David A. Hubbard, Jr., Virginia Department of Mines, Minerals, and Energy, Division of Mineral Resources, Box 3667, Charlottesville, VA 22903

Maps of selected karst features are published (1:250,000 scale) for two of the three sections of Virginia's Valley and Ridge Physiographic Province. Karst features selected to define the relative degree of karstification are sinkholes (karstic closed-contour-depressions) and cave entrances. The term sinkhole refers to: dolines, blind valleys, poljes, uvalas, etc. Sinkhole locations are determined by stereoscopic viewing of low altitude (approximately 4,000 m) panchromatic, aerial photography taken during leaf-off seasons. Cave entrance locations are from published and unpublished sources and the symbology only indicates a single or multiple entrance location. Karst features are plotted on a carbonate bedrock map differentiating sequences of Cambrian-Ordovician limestones interbedded with dolostones, middle-Ordovician limestones, Devonian-Silurian limestones, Mississippian limestones or non-carbonate rocks. The base map contains cultural and hydrological features, but no topographic contours.

Questionable features have been field checked. Problems arose with pseudo-sinkholes such as ancient-landslide sag ponds and old, open-pit mines. Additional problems have been posed by inaccurate TVA topographic maps on late 1940s bases, on which up to 10% of the features shown as sinkholes are misidentified. They are not topographic depressions and include hills. A number of features depicted as hills are sinkholes.

Mapping of the third and final Valley and Ridge Province karst section is in progress. Although sinkhole and cave entrance features may present a fair representation of the degree of karstification in Virginia, these features may not appropriately depict the relative degree of karstification in other areas of the United States.

Regional Mapping of Karst Terranes in Oklahoma

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The Oklahoma Geological Survey will prepare a map of the State at a scale of 1:500,000 to show karst terrains and associated environmental problems in Oklahoma. Surface and near-surface carbonates (limestone and dolomite) comprise about 6% of the surface area of the State, whereas sulfates (gypsum and anhydrite) comprise about 4% of the State. Areas of carbonates and sulfates will be differentiated and mapped separately as two zones: in zone 1 they are 0-6 m deep, and in zone 2 they are 6-30 m deep. Areas underlain by bedded salt (halite) within 300 m of the surface comprise 14.6% of the State, and they will be mapped as zone 3.

The Pennsylvania Cave Data Base

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The Pennsylvania Cave Data Base was designed to include geological, biological, and hydrological data, cave access information, and the usual name, length, map status, quadrangle, and coordinate information, all in computer accessible form. New cave discoveries are entered as information is received and existing entries are continuously updated. Information contained in the data base can be displayed on a map of Pennsylvania in various ways. A dot map of cave entrance distributions has been prepared.

A Karst Atlas For the United States: Concept, Justification, Feasibility, and How to Expedite

William B. White, Department of Geosciences and Materials Research Laboratory, The Pennsylvania State University, University Park, PA 16802

At present, the only document showing the distribution of karst in the United States is the Davies map published by the United States Geological Survey in 1986. The Davies map displays only areas underlain by karstic rocks with no indication of the type of karst or the intensity of karst development. If the maps were expanded from national to state scale, the types of information that could be displayed include: (a) Geology as outcrop area of limestone, dolomite, gypsum, or other karstic or pseudokarstic rock. (b) Surface landforms, mostly closed depressions, displayed as dot patterns, or mapped as some sort of intensity pattern. (c) Cave distributions either as dot patterns on a state scale or as some sort of cave length/unit area mapping. (d) Patterns of underground drainage. Data for constructing (a) are generally available from State geological maps and for some states there are limestone maps. Data for (b) are readily available on topographic maps but in this case there is too much detail on too fine a scale and the problem is to generalize the information. Most states now have cave data bases generated privately by caving groups. These data bases are computerized to varying degrees and there is also a greatly varying degree of public access to the data. Hydrological maps are the greatest challenge because there is very little systematic data in any form. Rather than a single map or set of maps, an atlas format with provision for text and photographs seems a desirable device for the systematic display of information.

HISTORY SESSION

The History of Durham Cave, Pennsylvaina

Bert Ashbrook,1257 Lehigh Parkway South, Allentown, PA 18103-3875

"The Cave, called the DEVIL'S HOLE, lying in Durham township, Bucks County, Pennsylvania . . . certainly ranks among the natural curiosities of this country, and deserves publicity whilst it has been but barely noticed by historians." A VISITANT, 1802

Now known as Durham Cave, this cavern was open during the last ice age and was occupied by several species now extinct or locally extirpated. Archaeological and historical evidence suggests Indian occupation until 1728. Eighteenth-century publications manifest that the cave was widely known. During the Revolutionary War, the Continental Congress attained the cave's owner of treason, confiscated the property (which had an iron furnace), and leased it George Taylor, a signer of the Declaration of Independence. In 1802, the cave was the subject of a minute description and temperature study.

In the nineteenth century, Durham Cave was surrounded by new iron furnaces, forges, quarries, lime kilns, railroad tracks, a canal, wharfs, and roads. Quarrying began destroying the cave c. 1850. By the 1870's, half the original 90 m of passages were destroyed, and quarrying under the drip line widened the remaining passage to 20 m in places. The huge room, now opened to daylight, only increased the cave's renown. Meetings and church services were held inside the ever more popular cave.

Several paleontological and archaeological excavations at Durham Cave from the 1840's until the 1980's were done by the likes of Henry Rogers (Pennsylvania's first state geologist), Henry Mercer (early archaeologist and speleologist), Joseph Leidy (vertebrate paleontologist), and Frederick Grady (Smithsonian paleontologist).

The Search For the Cave From Which Thomas Jefferson Described the Bones of the Megalonyx

Fred Grady, 1201 S Scott St. Apt 123, Arlington, VA 22204-4655

In 1796, Thomas Jefferson was sent some bones from a cave in Greenbrier County, Virginia. Jefferson described these bones, a femur fragment, ulna, radius, and some foot bones, as a new genus of mammal, Megalonyx. Jefferson reported the bones were found by saltpeter workers and gave the cave owner's name as Frederic Crower, an apparent mis-spelling of Frederic Gromer. Correspondence between Jefferson and John Stuart who sent him the bones, indicates the cave was about five miles from Stuart's home and contained saltpeter vats. While Organ Cave has been previous cited as the location of this discovery it can be eliminated as it was never owned by Gromer. The discovery of two letters written by Tristram Patton the next owner of the cave indicates the cave was in Monroe County near Second Creek. Monroe County was separated from Greenbrier County shortly after the discovery of the bones. Patton described the cave and the indicated more bones were there. This information and other material accumulated over several years leads me to suggest that Haynes Cave was the actual discovery site. Two years ago, two fragments of a Megalonyx scapula were found in Haynes Cave and tend to support this suggestion.

An Informative Pigeon River, N.C. Nitre Department Envelope

William R. Halliday, Hawaii Speleological Survey of the NSS, 6530 Cornwall Court, Nashville, TN 37205

In 1993, I acquired a stampless envelope addressed to Charlie W. Slagle, Franklin, N.C., with a hand-written "manuscript" postal cancellation stating "Pigeon River NC Paid 10. In the corner appropriate for a return address is the hand-written statement : Nitre Department Official Business.

No caves are known near Pigeon River, N.C. although the Confederate also manufactured saltpeter from passenger pigeons droppings.

The Cave of New York's City's Central Park: A Forgotten Marvel

Cato & Susan Holler, P.O. Box 100, Old Fort, NC 28762

Caves occur in the strangest places. A once popular but now almost forgotten cave in New York City's Central Park is a good example. Part natural and part artificial, the little cave at one time provided a much-appreciated source of adventure to park visitors. One could visit the cave from the lakefront by either rowing up to the entrance in a boat or by descending a series of steps hewn out of the rock along the shore. At the far end of the narrow passage was another entrance to the north.

Unfortunately, it was necessary to close the cave somewhere around 1930 due to its misuse by tramps. Both the waterfront and landward entrances remain sealed. Today, homeless individuals can be seen occupying the shallow shelter of the lakeside entrance.

There are no immediate plans of reopening the little cave due to safety considerations. We can still enjoy 19th Century photographs and documentations.

Catacombs of Yucatan: A Brief Blink in American Spelean History

George N. Huppert, Department of Geography and Earth Science, University of Wisconsin - La Crosse, WI 54601

The Catacombs of Yucatan (also called Black Hammer Cave) is located in southeastern Minnesota in Black Hammer Township of Houston County. The cave was discovered in the late 1870s or early 1880s by local landowners. There were reports of burials and other artifacts found in the cave but, if they ever existed, there is no evidence of it now.

For a short time in the early-to-mid 1930s, the cave was the scene of a thriving commercial enterprise. This short-lived business included not only the show cave (small and of minimal quality) but also tourist cabins and a restaurant/night club. The cave was electrically lit which was unusual for a show cave in a very rural setting in the 1930s. The power source was an on-site generator in its own powerhouse. Barely a trace of the cave improvements remain today. The buildings have been moved to other locations, the road and parking area have been plowed over and, sadly, the cave has suffered great damage by vandals. The business lasted only a few years, a victim of its isolated setting and the "Great Depression".

Karst, Cannon and Captain Marshall

Hal Joerin, 2828 Red Leaf LN., Southfield MI 48076-2929

A review of the literature detailing events of the Battle of Stones River during the American Civil War allude to the landforms aiding Confederate forces in the capture of Union artillery. These features have been described variously as rocks, boulders, limestone ledges and even mud. An examination of the ground itself reveals features of interest to an observer aware of karst terrain.

The Mason/Dixon Cave and the Significance of Its Documentation

Patricia A. Rosevear & Richard E. Rosevear, 1236 Union Street, Allentown, PA 18102-4610

During the survey of the boundary between Pennsylvania and Maryland, Charles Mason and Jermiah Dixon took an excursion to visit a cave. Mason described the cave in his journal entry for 22 September 1765. The late Russ Gurnee thought that this may have been the earliest documentation of a cave in the United States.

William Davies stated in 1966 that Jonathan Carver's 1778 account of his 1766 exploration in Carver Cave, Minnesota was the oldest mention of a large cave in the United States. Durham Cave in Bucks County, Pennsylvania has also been suggested as the earliest documented United States cave because of it's inclusion on Schull's map of the Province of Pennsylvania in 1770.

The location of the "Mason/Dixon Cave" was determined and documentation predates even Mason's account. Joseph Spangenberg gave a general location and description of the cave in 1748.

The cave has rich history as a saltpeter and commercial cave. Native American artifacts and the bones of prehistoric animals have also been excavated from the cave.

INTERNATIONAL EXPLORATION SESSION

Gunung Buda Expedition, Sarawak, Malaysia

Dave Bunnell & Djuna Bewley, 320 Brook Rd., Boulder Creek, CA 95006

Sixteen American and two British cavers joined guides from Mulu National Park on a two-month expedition to Gunung Buda, a limestone massif just north of the park. From the beginning, we found plenty to explore and surveyed over 29 km in 18 caves. The largest of these, Green Cathedral, connected to the previously mapped Beachcomber complex, netting over 10 km for the system. Climbers pushed a series of phreatic ramps in the Snail Shell system to a height of over 490 m, making it Borneo's deepest (or tallest?) cave. An unusual fissure in a large sink was pushed to a sump at -139 m, the deepest know pit in Borneo. The "Big Feature", an intriguing sink that thwarted earlier exploration efforts, revealed 200 m of grand borehole leading to a sump.

Many of the caves were characterized by unusual corrosional features, including guano-carved potholes and forest of pinnacles up to 5 m high. Cave life included large poisonous spiders and centipede, snakes, white and black crabs, many bat species and large swiftlet populations.

While many leads remain, the expeditions findings thus far may have sparked sufficient government interest to declare Gunung Buda a nationalpark, bringing a halt to destructive logging practices in this sensitive karst region.

Cave Exploration In Bulgaria

Charles Crandell, P.O. Box 5193, Sun City West, AZ 85375

Under the former Eastern Block alliance Bulgarian caver pushed the limits of their former socialist government. When everyday Bulgarians could not travel internationally, cavers of this eastern European country were conducting expeditions in Spain, Cuba, and Armenia. The "National Speleological House", in the middle of the Karlukovo Karst Region, is a testimony to their zeal and craftiness. Today, Bulgarian cavers are on the forefront of entrepreneurship and speleology.

Inlandsis 1994: Glacial Speleology Into The Greenland Icesheet

Diana Gietl & Marc Tremblay, 11700 Avenue Royale, Beaupré, Québec, G0A 1E0

The Greenland ice sheet (inlandsis) margins are subject to a meltwater process making subglacial drainage tunnels. The exploration of those ice caves is generally hazardous at the resurgence level but possible at the inlets, usually vertical shafts that require combining single rope techniques with ice-climbing skills. This enables modern scientists to peer directly into the glacier instead of staring at ice cores. During September 1994, a team of 13 spent 2.5 weeks on the inlandsis exploring ice caves at about 50 km east of Kangerlussuaq, 25 km into the ablation zone. The site is located just north of the arctic circle on the west coast.

In a karst-like fashion, the surface meltwater enters fractures which enlarge into immense shafts. The French call these shafts "moulins" or watermills because of the groaning noise of water cascading down. There is a critical time period for visiting the moulins. Too early in the season, the volume of 00 C water prohibits entry and too late, snowfalls cover the entrances.

Studies of the inlandsis attract scientists like glaciologists researching mechanics and hydrogeology of the immense glacier or biologists looking for the tiny organisms trapped in the ice. The expedition explored and mapped eight moulins which averaged between 20 m and 60 m deep with the exception of Paaqitsoq, which was bottomed to a deep lake at 80 meters of depth. The same moulin was explored down to 175 m the previous year, still the deepest explored in ice.

Exploration at Arroyo Grande, Chiapas, Mexico

David R. West, 13610 Arctic Ave., Rockville, MD 20853

Over a six year period, an international group of cavers explored and surveyed caves and pits in a 25 km^2 valley in this southern most Mexican state. There are both long horizontal developments as well as deep pits.

Early on we began a "resurvey" of Cueva del Arroyo Grande. A demand for two degree accuracy on mandatory backsights and quality sketches assisted with connections, and the cave is currently the state's longest at 10,222 m. It lies within meters of connecting to Cueva Queso Grande, which has an additional 2,267 m of surveyed passage. Many entrances and ease of traverse have made for pleasant surveying.

Many 100 m to 200 m pits have been surveyed, as well as two pits which are 278 m and 283 m deep. We have surveyed more than 30 caves or pits and have covered relatively little of the valley.

PALEONTOLOGY SESSION

The First Record of Arctodus Simus From Virgina

Fred Grady, 1201 S Scott St. Apt 123, Arlington, VA 22204-4655

The discovery of a partial skeleton of the extinct giant short faced bear Arctodus simus from Island Ford Cave, Alleghany County is the first discovery of this species in Virginia. The skeleton was discovered in a tight muddy passage and consists of much of the skull, one side of the mandible, vertebrae, rib parts, sternum parts, scapula parts, both humerae, 1 ulna, 1 radius, most of a front foot, pelvis parts, 1 femur, 1 tibia, 1 complete fibula and part of another fibula, 1 complete hind foot, and 2 ankle bones from the other hind foot. The skeleton is of a relatively small individual especially with regards to the dentition. It is a mature adult individual and probably a female.

Is This Cave Paleontologically Significant?

David A. Hubbard, Jr., Virginia Cave Board, P.O. Box 3667, Charlottesville, VA 22903

By 1985, approximately 2,500 caves were recorded in Virginia, 224 (9%) of these caves were included on the Virginia Cave Board's revised Significant Cave List. Only 12 Virginia caves were recognized as paleontologically significant.

Vertebrate skeletal accumulations in caves result from pit falls, anthropogenic activities, animal lairs, roost sites, wash- ins, etc. No less potentially significant are pollen and invertebrate remains incorporated in speleothems. Most of these example deposits are at least partially obscured and their study results in the destruction of the deposits. The study of such deposits must be conducted by or directed by professionals. These deposits are protected in Virginia by State law. In some cases, the fossils themselves may be less important scientifically than the context in which they were deposited. Context determination may require far more knowledge and attention to detail than the comparative work typically required to identify the organisms.

The fossils existing in the rocks in which caves are formed may be paleontologically significant and are typically exposed in rock outcrops. In Virginia's covered karst, the fossils in the carbonate rocks may be more readily observed in caves than in weathered outcrop. The occurrence of some exposed fossils may warrant the listing of a cave as paleontologically significant. Such fossils exposed in caves are protected by state law, but observation and identification can provide pleasure and knowledge to the caver, the speleological community, and the paleontological community.

SURVEY & CARTOGRAPHY SESSION

Fundamentals of Computer-Aided Drafting Applied to Cave Cartography

Bert Ashbrook, 1257 Lehigh Parkway South, Allentown, PA 18103-3875

Computer-Aided Drafting (CAD) can produce finished cave maps at any scale. Three-dimensional screen projections enable visualization of vertical caves but are cumbersome to use. CAD maps on paper are more practical for horizontal caves.

Traverse lines may be imported into CAD programs or data reduction may be incorporated into the software. Scanning sketches directly into CAD programs is difficult. Walls are more feasibly transcribed as lines and "smoothed" mathematically, or deduced from "left / light / up / down" data. Detail may be custom-drawn or inserted from libraries of standard symbols. Special hatches and line patterns are useful. The scale of the final presentation affects detail insertion.

In CAD, related data are sorted into "layers." Layers may be displayed or hidden at will, producing different maps for different purposes. For example, maps for mop-up surveyors might display survey station layers which would be hidden in publication maps.

Experienced hand- and CAD-drafters draw with equal speed, but CAD is significantly faster when changes are necessary, especially for large caves. "Working" maps are eliminated. New data may be added indefinitely and maps produced at any time, so inked maps no longer signify project milestones. However, closing loops is problematic for some software.

CAD permits neat lettering using many fonts. Map elements may be moved easily to achieve balanced layouts. Although CAD enables sloppy drafters to do neat work, CAD does not replace the artistic talent and attention to detail required of great cartographers.

Care and Calibration of the SON1N Combo PRO: An Electronic Distance Measuring Tool

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With proper care and calibration the SONIN Combo PRO can be used in place of a tape for cave surveying. The unit in a cave environment can be used in the single unit mode to measure a flat surface such as a ceiling up to 60 feet (20 m) and in the dual unit mode up to 200 feet (60 m). Other useful features are the ability to keep a running total of the survey length and the temperature at each station.

In the dual unit Node, the SONIN Combe POLO uses a target The target is activated with an infrared light signal and then sends sound waves back. This enables the distance to be measured through small or narrow openings.

New features and Uses for CAPS

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CAPS is an available software program that converts raw survey data to a 3-D screen plot with sides, notes and the ability to display pictures at each station. Some of the new features are 3-D with glasses in order to relate to the depth of the cave and a new search feature that shows where the requested information was found by placing small circles at each station where a match occurred. Any ASCII text editor can expand the notes for each station and the editor can be used from within CAPS to edit the notes. One can view the raw survey data in a table and edit the data.

Standards for Sketching

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The key component of any cave survey is the information that is produced. On most cave surveys that information is in the form of a sketch or series of sketches and the notes. If when a team returns to the surface and the information brought out of a cave is not readable, hard to understand, or lacking in usable data, then the time spent by the team has been wasted and, more importantly, the cave has been impacted without producing any viable results. In the caves of Carlsbad Caverns National Park, this impact to the caves with poor or no usable results is unacceptable. The caves of the park are very fragile and each team entering an area will have an impact. Therefore, it is imperative that good information be gathered. The sketcher is the

most important member of the survey team. Standards have been developed to give sketchers knowledge of what is expected when they return from a survey trip. These standards will be discussed and examples will be given of bad as well as good survey sketches and notes.

The Computerization of the Cave Map

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The computerization of many types of activities has tended to occur in identifiable and somewhat predictable stages that can be described nearly independently of the application. Stage-1 (simple)—portions of the activity which were previously performed without computers are "simply" computerized. Some portions are still done the old way. Stage-2 (enhanced)—the computerized version of the activity is "enhance to provide additional functionality. Capabilities are provided which were seldom done before because they were either too time consuming or too difficult. Stage-3 (complete)—the computerized version is further enhanced by the use of more sophisticated algorithms and added functionality, to the point where all or nearly all operations are performed on the computer. The computerized process completely replaces the previous manual process. Finally, Stage-4 (redefinition)—the functionality of the computerized version greatly exceeds that of the traditional activity. Aspects of the computerized version are recognized as new manifestations of existing ideas, processes, and/or products. The fundamental terms previously used to describe the activity are redefined. The activity of creating and viewing a cave map is undergoing such a "redefinition".

ADDITIONAL ABSTRACTS FROM THE 1996 NATIONAL SPELEOLOGICAL SOCIETY NATIONAL CONVENTION IN SALIDA, COLORADO

Is It Condensation Corrosion or Something Else?

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Many morphological features of caves have been explained by a subaerial process called condensation corrosion. Condensation collecting on cave surfaces absorbs carbon dioxide and becomes corrosive. The subsequent dissolution erodes away ceilings, walls, and speleothems, creating hemispherical domes or cupolas, among other features. The calcite mass is disposed of through the walls by capillary action, traveling to the lower portions of the passages by gravity, and depositing there as seepage coral through evaporation. If condensation collects at orifices, where moisture-laden air emerges from passages below, rims of calcite are formed around barren channels which appear scoured of all secondary deposits. In the United States, these features appear only in caves west of a line roughly drawn from western Texas to the Black Hills of South Dakota. The caves of the Basin and Range Province of western Utah and eastern Nevada present a great diversity of cupolas, rims, vents, coral, and other related phenomenon. While some of these fit the subaerial condensation corrosion model for their origin, many others with identical appearances may be more appropriately explained by subaqueous processes. The morphology of these channels and associated rims, and their locations within the passages would be improbable if air currents were involved.

The Origin of Folia

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Folia, strange-appearing and relatively rare speleothems, are generally regarded as forming in relation to a fluctuating water surface. While investigating folia in Nevada's Goshute Cave, several clues were found that point to a different origin. In most caves with folia, the lowest exposures of folia ribs are usually covered with water or have been buried by sediments. In Goshute Cave, however, there are three instances where the lowest folia ribs appear midway in the cave's vertical extent, allowing a unique insight as to their origin. When water saturated with calcium bicarbonate ions emerges from an orifice, there is a profuse outgassing of carbon dioxide (and calcite nuclei are precipitated. Carried by bubbles or water that has greater buoyancy because of higher temperature, the calcite nuclei flow upward along down-facing walls. Nuclei adhere to the walls, at first creating small sub-horizontal ribs spaced a few millimeters apart and protruding only slightly. These tiny ribs have limited horizontal extent and interleave with each other. Eventually, enough calcite accumulates on the ribs to form cavities that protrude enough to trap beneath them. When the accumulated exceeds the capacity of the cavity, it bubbles from underneath. The turbulence of bubbling causes deposition of more calcite at the cavity edge. Folia then, are the upside-down equivalent of rimstone pools, except that the upside-down pool of folia is filled with gas. What have been described as folia composed of mud have a different origin and appearance.