THE MAVERICK BULL

THE MONTHLY NEWSLETTER
OF THE MAVERICK GROTTO

February 1991

THE MAVERICK BULL is the monthly newsletter of THE MAVERICK GROTTO, an internal organization of the National Speleological Society (NSS 6-322). The editor invites all individuals and other grottos to submit articles, news, maps, cartoons, art, and photographs. If the material is to be returned, a self-addressed, stamped envelope should accompany it.

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EXCHANGES: THE MAVERICK GROTTO, will exchange newsletters with other grottos. Contact the editor.

COMPLIMENTARY NEWSLETTERS: THE MAVERICK GROTTO will provide complimentary newsletters to persons or organizations who provide cave access (i.e. landowners) or otherwise provide assistance to cavers. THE MAVERICK GROTTO will also provide three free issues to persons interested in becoming members.

MEMBERSHIP POLICY: Any individual with interests, beliefs, and actions consistent with the purposes of THE MAVERICK GROTTO and the National Speleological Society is eligible for membership. Acceptance of new members is based on payment of dues and a mandatory three trip requirement with at least three different grotto members. These three members shall act as sponsors. At least one sponsor must attend the meeting at which the membership vote is taken. A two-thirds majority vote of the members present will be required for acceptance.

MEETINGS: Meetings are held the second Tuesday of each month, at SMOKEY'S RIBS, 5300 East Lancaster, Fort Worth. It is a little less than one mile west of Loop 820 and next door to a K-MART. The time is 7:00 P.M., and the food is good.

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MAVERICK GROTTO
CAVING
TX-OK-AR-MO-NM

February's cover picture features your editor while in Ernest Parker's Advanced Rappelling Course last year. Once again Mr. Parker has graciously offered his professional expertise in Vertical Applications of Caving.

The course is 32 hours long, with 8 hours of classroom instruction, and 24 hours of hands-on instruction. The course includes four methods of rappelling, three methods of ascending a rope, four methods of belay, types of equipment used, equipment construction, inspection and care, self rescue and basic partner rescue from a line. Problem solving and safety are stressed.

The course is open to beginners as well as those having experience. The first day is the classroom portion, which will be held at the National Guard Armory on Highway 180 in Mineral Wells. Going west from DFW the armory is on the right of the highway, past the golf course. Entering Mineral Wells from the east, there is a large sign indicating a National Guard training site on the old Fort Wolters Army Base. Ignore this sign!

There is the possibility due to the war in the Middle East, that the National Guard unit in Mineral Wells will be activated and sent to the war zone. If this happens, applicants will be notified of the change in the locations of the classroom session.

The hands-on training will be held at Lake Mineral Wells State Park, located on Highway 180 at the eastern city limits of Mineral Wells.

Class starts at 8:00 A.M. and ends at 5:00 P.M. There is a one hour lunch break. Many prefer to bring a picnic lunch, but you can drive into Mineral Wells.

There is lodging available in Mineral Wells and camping at the state park for those wishing to stay overnight each weekend. For camping reservations and fee information at the park, call (817) 328-1171, 8-5 daily.

There will be a $25 course fee per person to defray instructors expenses. For those not camping at the park, there is a park use fee of $2.00 per car per day.

Each student MUST bring to class: helmet, leather gloves (no farmer's fencing gloves or welding gloves; too stiff), cleated shoes or boots, a seat harness or 25 feet of 2 inch tubular webbing, and about 6 feet of inexpensive rope for knot tying practice. If you have any other vertical gear please bring it. Rappelling ropes are especially needed.

An accurate head count is needed, so please contact Ernest Parker at (817) 447-8344 (unlisted) if you wish to attend. Sorry about the increase in the course fee, but everything just keeps going up.

Meeting Minutes for January 1991.
The change of officers was announced, see page 2 for a list. Dues are due $10.00 for 1991, make a check out to our treasurer, his address is on page 2.
Butch Fralia will check on our being incorporated and get tax status for the Grotto. He will check with Jay Jordan to fill out the necessary forms and get the proper procedures. Butch will be reporting back to the officers at a later time.

Ernest Parker is planning to have another Vertical Class, if you are interested call Mr. Parker at (817) 447-8344 (unlisted).

April - TSA spring Convention, watch for more information on exact dates and time.

Cave Task force meeting; Butch, Ed, etc. there is a need for work in the Gorman cave area. Trail access is needed to Big Cave, also searches for caves around Big Cave will be conducted. Gating at the end of Big Cave is still a possibility. John Williams a coordinator of cave activity in the state, Andy Sampson is director of TP&W and incorporates caves into the state P&W system. New state parkland requires acquisition funds each year. Keep an eye out for caves on private property for future acquisition. Big Bend Caves are granite.

Archeologist Ron Ralph of the state will be at Gorman on the May trip to identify the Indian camp. Archeology seminar, Rons an old time caver and fun to be around - it will not be dull.

Bog - Whirlpool cave. Doug Allen - notices were sent to TSA members for the first of next week.

Powell's Cave in Houston. February trip. 3-BBQ goats from the Bexar Grotto newsletter Feb 22-24. Call T Holsinger at (512) 476-9031

March Lechugilla Trip call Pat Chambers (404) 378-2836 this is limited to 12 new people. Call now to reserve yourself a place.

March 1991 National Geographic's Cover
Jan, Feb 1991 Goods 3 mile hill - Wayne Walker - severe weather conditions Orin Trenburger
Ft. Stanton New Mexico maybe trips in Jan 6100 ft elevation. Thursday returning Sunday. Call Oren Trenburger 522-2710 (office) or 349-0208 (home).

Next Meeting: Gary Griffith speaks. Seat Harnesses.
Program: Explorer Scout Post: John Travers and Shelly Robinson

Exploring Executive Longhorn Council (817) 738-5491 or
571-0804 co-ed Boy Scouts young adult division.
$20.00 fee for chartered organization (grotto) we have
options: 1) Sponsor Explorer Post
2) Work with existing post
3) Don't Participate

The previous were deciphered notes of the January Grotto Meeting. The editor wishes to thank Dave Milholland for his fine work in advancing the sanskrit language. It is a possibility I have misspelled some peoples names or gotten entire sentences mixed up while translating. All kidding aside I do thank Dave for taking notes last meeting, else we would not have even this much to read. Thank you Dave.

The following article was reprinted, with permission, from the Ft. Payne, Alabama newspaper, The Times Journal. It appeared in early Dec. 1990, I'm not sure of the exact date.

I would also like to take this time to apologize for last months newsletter. it was mailed out and I'm not sure what happened, but I promise to do everything possible to ensure that we don't have a repeat in the future.

Steve Gentry

50 rescuers pull man from Moses' Tomb

•Luck and skill on line for deep cave rescue

By NIA CATO
The Times Journal

In one of the most dramatic rescues in DeKalb County's history, a man was lifted from the bottom of a 210-foot pit Sunday night, after lying on jagged rocks for over five hours with a broken back.

As the victim, 33-year-old Tom Harris of Tallahassee, Fla., was finally being lifted out of Moses' Tomb, he said to one of the paramedics, "Y'all must do this sort of thing all the time."

Fortunately for Harris during his ordeal, he did not know that this was the first-ever pit rescue for the team — and that a rescuer had died during another rope rescue attempt less than a month ago.

That scene, in which 26-year-old Greg Neely, a LifeForce paramedic, fell over a cliff where he had just rescued a mountain-climber, was still fresh on the minds of rescuers Sunday afternoon.

The scene of the accident, Moses' Tomb, is known among cavers across the country, and drew Harris and four Atlanta cavers for a Sunday exploration. Located just north of the Sulphur Springs community between Sand and Fox Mountains, Moses' Tomb is more of a pit than a cave.

Its shape is described as "like a champagne bottle." The opening measures 40-44 inches across, then the "neck" descends 30-40 feet past a ledge, widening to a 30-40-foot diameter at its 210-foot depth.

Harris was the middle man in his five-man team. Two of his companions were awaiting him at the bottom, and the other two were still at ground level.

No one knows for sure what happened in the darkness, but about 100 feet into his descent, Harris lost control of his rope and fell into an "out-of-control rappel."

Since the only light in the pit was the headlamps each man wore on his helmet, the cavers at the bottom could not see Harris falling.

When Harris landed on the rock-strewn floor, his companions called to the surface cavers. One of them ran for help, while the other stayed to communicate with those below.

Harris's rescue was made possible by a string of coincidences. First, one of the nation's foremost rope rescuers was nearby, training a group of volunteers at Buck's Pocket.

Jerry Smith of Rome, Ga., acknowledged as a world-class expert in rope rescue, was teaching a group of volunteers from Rainsville and Fyffe Rescue Squads when they were called to the rescue scene. Those 15 volunteers put their skills to the test through "trial by fire," Smith said.

Smith performed hundreds of rope rescues during his 10 years as a rescue operations leader in his native California. He now travels the U.S. teaching rope rescue and has written a book on the subject, "The Rope Rescue Manual."

Second, the recent death of

See RESCUE, page 3

Rescue

Continued from page 1

Greg Neely gave a heightened tension to the rescue. The loss of one of their own was on the mind of each rescuer there, especially those paramedics who actually went down into the cave with the victim.

Third, another rescue at Little River Canyon just seven weeks ago had gotten off to a rocky start through misguided communications. That accident sparked renewed efforts among rescue groups at better communications and more complete knowledge of which rescuer has specific skills.

Fourth, unparalleled organization and leadership was called to play in Harris's rescue, thanks to Smith's technical expertise in rope rescue and DeKalb Emergency Management Coordinator Ricky Little's orchestration of the 50-plus volunteers, representing three states and about ten rescue groups.

Ider Rescue Squad received the initial call. Others later involved in the rescue effort praised the Ider volunteers for "being professional enough to call for more help."

They summoned the Rainsville Rescue Squad, who has several volunteers trained in rope rescue. That team, though, was at Buck's Pocket with their instructor, Jerry Smith. The entire class volunteered for immediate "on-the-job training."

Smith took control of the scene and sent a paramedic down into the pit to examine and stabilize the victim.

Anthony Clifton, a DeKalb Ambulance Service and Rainsville Rescue Squad paramedic, found Harris barely conscious. Harris had suffered a compound fracture in his lower left leg, a serious cut to his right elbow, and complained of severe pain in his back.

That [illegible] Clifton to treat the victim as though his spine were broken — which indeed it was. He later regained consciousness enough to talk and even to joke with rescuers.

The next group summoned was Walker County (Georgia) Cave, Cliff and Pit Rescue Team. That group is recognized by the National Speleological Society as the responding cave rescue unit in the tri-state area, being responsible for rescues in 6,000 caves in the Tennessee-Alabama-Georgia triangle.

They dispatched a three-man experienced cave rescue team from Chattanooga to lend their cave rescue expertise to the operation.

Above ground, a 3-to-1 mechanical advantage system was rigged up, using anchor points in the ground and a system of pulleys. That allowed the five-man hauling team to pull the patient out of the pit three times more easily.

Communications for the rescue were critical, because radio waves do not travel through rock. Two rescuers stationed themselves at the mouth of the pit during the entire ordeal, relaying radio messages from the cave to DeKalb Ambulance Service and Baptist Medical Center.

Two more medics — Paul Mince, an intermediate EMT from DAS and Rainsville Rescue, and Jerry Slaughter, a paramedic from Huntsville Emergency Medical Service — descended into the pit to "package" the victim.

As the hours passed, time became critical. The cave maintains a 52 degree temperature year-round, and hypothermia was a distinct possibility for the victim. Meanwhile, the other two cavers helped the medics with their friend.

Harris was strapped into a Stokes basket, a rigid patient [illegible] res-cuers. The victim had to be strapped in so securely that his body would not slip even a half-inch when he was lifted out of the pit.

Dennis Curry, one of the Chattanooga cave rescuers, climbed down to attend the victim during the ascent. He was on a separate static line, and guided the victim past rocks and ledges during the narrow ascent.

When they reached the ledge, the stretcher was turned vertically, so that he could be lifted through the neck of the pit. Rescuers said it was a tight fit.

Relay teams were set up to carry the stretcher down the mountain for three-quarters of a mile to the landing zone where a LifeForce helicopter waited.

Harris was flown to Erlanger Medical Center in Chattanooga, where he remains in critical condition in the trauma unit.

By the time the last two cavers and the paramedics got out of Moses' Tomb, about 10 hours had passed since Harris's accident.

The drama ended with volunteers denying that they were heroes, instead hailing each other as part of a well-orchestrated team.

Paul Jones, an intermediate EMT with Rainsville Rescue Squad and an experienced rope rescuer, called it "the slickest rescue I've ever seen. All the volunteers — no matter which group they were from — worked together beautifully."

"I can't say enough good things about the Ider people and Ricky Little," Smith said. "The key to difficult rescues is knowing who your trained people are. It was terrific that the rescuers from Rainsville and Fyffe had just finished training an hour earlier, so it was fresh on their minds. They learned their [illegible]

Davis, Donald G.—Helictite Bushes—A Subaqueous Speleothem?: *NSS Bulletin* 51 120-124.

HELICTITE BUSHES— A SUBAQUEOUS SPELEOTHEM?

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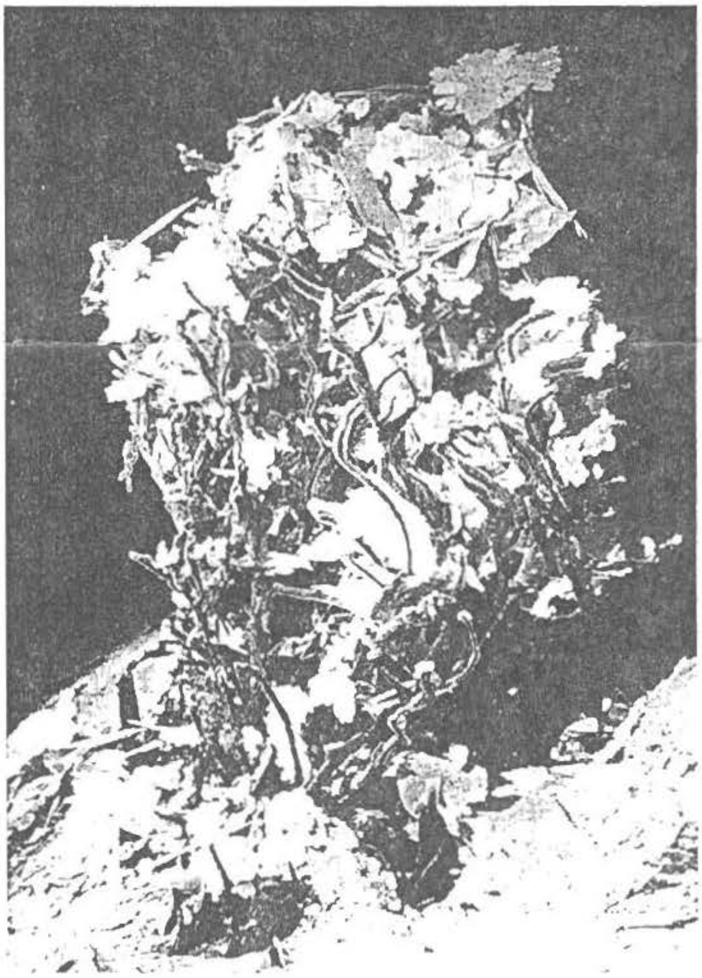
Several lines of evidence suggest that the "helictite bushes" of Wind Cave grew underwater, probably where localized plumes of thermal water once welled up into ambient groundwater then standing in the cave. In their physics of origin, helictite bushes may be more closely related to features like submarine "smoker chimneys" than to normal helictites. The chemistry of helictite-bush growth has not been investigated, but may involve calcite crystallization by the "common ion effect" where calcite-rich and gypsum-rich waters interacted.

"Helictite bushes" (Fig. 1; see also the cover of the February 1988 *NSS News*)—are a much admired, but little studied, feature of Wind Cave, South Dakota. Writers on Wind Cave have treated them as exceptionally large and complex variants on ordinary helictites, but have not regarded them as fundamentally different in character or origin (A. Palmer, 1981, 1988; Shafer, 1988). However, there is now reason to suspect that helictite bushes are far more unusual and interesting speleothems than has been assumed.

"A helictite," as defined in Hill and Forti's *Cave Minerals of the World* (1986, p. 42; 45), "is a contorted speleothem which twists in any direction, seemingly in defiance of gravity . . . All helictites originate by capillary flow under hydrostatic pressure," the rate of feeder flow being so slow that no hanging water drop is formed and crystallographic forces override gravity in directing the helictite's growth. This explanation is applied specifically to Wind Cave by Shafer (1988): "The helictite bushes . . . may form when water seeps from the cave through pores so small that the flow is controlled by capillary action and not gravity. This allows water to move uphill and deposit calcite against the force of gravity." Such interpretations assume that all helictites are subaerial (i.e., grow in air-filled, not water-filled, caves).

Wind Cave helictite bushes, however, show conspicuous evidence of former submergence, such as calcite rafts lodged in their branches. Arthur N. Palmer's *Geology of Wind Cave* (1981, p. 28) accounted for this as follows: "The helictites formed above water, and the rafts settled over them during a later rise in the water table."

Are these explanations correct? In Lechuguilla Cave, New Mexico (Carlsbad Caverns National Park), I recently discovered helictites which have grown beneath the water of shelfstone pools (*NSS Bulletin*, publication pending). This raises the question whether some helictites in other caves—particularly the helictite bushes of Wind Cave, with their peculiar morphology and signs of inundation—have also grown underwater.



Helictite bush near Calcite Lake in Wind Cave, adorned with calcite raft fragments that settled onto it when the lake level was several meters higher. Height of bush is approximately 40 cm. Photo by Arthur N. Palmer.

On May 28 and 29, 1988, with Wind Cave National Park permission and Ed LaRock's guidance, I examined several dozen helictite bushes between the Garden Gate and Calcite

Lakes for evidence bearing on this question. Nearly all Wind Cave helictite bushes are found in or near this downdip section of this axial passage complex which bisects the known cave. They typically grow upward from floors, often in intricately intertwining branching patterns, and are uniquely distinct in morphology from either ordinary subaerial helictites or from the downward-angling, usually unbranched spaghetti-like Lechuguilla subaqueous form. Several observations relevant to their origin were made:

(1) *All* Wind Cave helictite bushes observed show evidence of former submergence: calcite rafts lodged in branches; encrustations continuous with crystalline subaqueous calcite wall crust; and in some cases, films of compact, apparently water-laid sediment on upper surfaces of helictite arms.

(2) *No* bushes observed are now "alive," (i.e., none can be shown to be actively growing in air).

(3) Subaerial helictites are created by seeping water which will normally have grown dripstone, flowstone or shields in the same area; these vadose speleothems are totally absent from this section of Wind Cave.

(4) The great majority of helictite bushes grow upward from floor crusts which were apparently calcified before drainage of the cave. The bushes often originate beside pre-crust breakdown blocks or other obvious discontinuities that provide permeable places in the crust. During or after drainage, these floor crusts were extensively undermined and broken by subsidence of their sediment substrates, but no helictites appear to have grown after this episode of crust breakage. Even when floors were intact, it would seem unlikely that descending vadose moisture would take the most indirect possible route by bypassing outlets in walls and ceilings only to ooze up from the floors.

(5) The capillary-seepage growth mechanism of subaerial helictites typically constrains their internal feeder canals to a very small diameter (specifically .008 to .5 mm, according to Hill and Forti, p. 43). In striking contrast, Wind Cave bush branches (whose cross-sections are observable in many pieces broken naturally or by careless cavers) usually have large and irregular internal canals, often 3 mm or more in minimum diameter, and 12 mm or more along the wider axis in flattened branches (the canals are occasionally wider than the wall of the branch is thick). In air, it would be quite improbable that a helictite with a large internal tube could grow very far before gravitational effects on overflow or leakage caused conversion to a soda-straw mode. Straws, indeed, are often seen growing from subaerial helictites but *never* from any Wind Cave helictite bushes examined.

George W. Moore (pers. comm., 1989) has pointed out that helictite growth in air requires that the terminal orifice be small, but that, because of high acidity created by confined CO_2, the internal canal may be enlarged by resolution. Helictite bush sections have not been critically examined for evidence of truncated growth layers that would result from resolution. However, in bushes not heavily overcrusted, the irregularities of internal and external outline tend to coincide, suggesting that the cavity dimensions are original and not secondary features. Moreover, internal resolution would lend itself to perforation, leakage, and consequent soda straw growth, which, as noted above, is not observed.

(6) One specific helictite bush, in an alcove on the west side of the passage a few meters south of the Emperor Maximus bush, grew upward from the floor crust several cms, where its branches encountered an overhanging ledge. The branches thereupon merged into a thin crystalline crust, whiter than the adjacent walls, for several cms up the overhang. At a sharp breakover to an upward-facing slope, helictite branches at once emerged from the upper edge of the crust and resumed independent upward growth for several more cms. Such phenomena would be consistent with a deposit created by an ascending fluid plume within a surrounding water body—but not with behavior of subaerial helictites, which, if their feeder canals were disrupted by intersecting a wall, would have no way to "remember" original orientation and resume coherent growth above.

A. Palmer—who had been informed of the subaqueous Lechuguilla Cave helictites—has recently presented, in his updated Wind Cave geology book (1988, p. 33), a revised subaerial hypothesis which addresses some of the above points: "It is possible for helictites to grow under water, but only in unusual chemical conditions. These [Wind Cave bushes] most likely formed in air, growing upward from deposits of weathered limestone powder that accumulated from upper levels, apparently when the powder was moistened by pools of water immediately below. Later rises in water level coated them with layers of calcite, making them thicker and sturdier."

Palmer's new model does account for their prevalent growth from floors and the lack of association with vadose decorations, as well as the universal evidence of inundation (assuming that growths originating near the water table would inevitably be flooded by normal fluctuations) and the failure of bushes away from the water table to remain active. It does not, however, explain their having feeder canals larger than capillary size (resolutional enlargement of canals would be unlikely in Palmer's wicking model, because CO_2 in helictite-forming water derived from open pools should already have reached equilibrium with the relatively low CO_2 level to be expected in cave air). Helictite growth in a water medium would place no constraint on the dimensions of the canals. Nor does Palmer's new mechanism account for the bush that reorganized its upward growth after interruption by a ledge. Finally, a wicking process, such as Palmer suggests, should take place anywhere that standing cave water abuts a shore of absorbent material and where the cave atmosphere allows evaporation. This is a situation common enough that one might expect helictite bushes, if caused by it, to be widespread in Wind Cave and other caves; yet they are extremely localized without apparent correlation with factors that would have favored wicking.

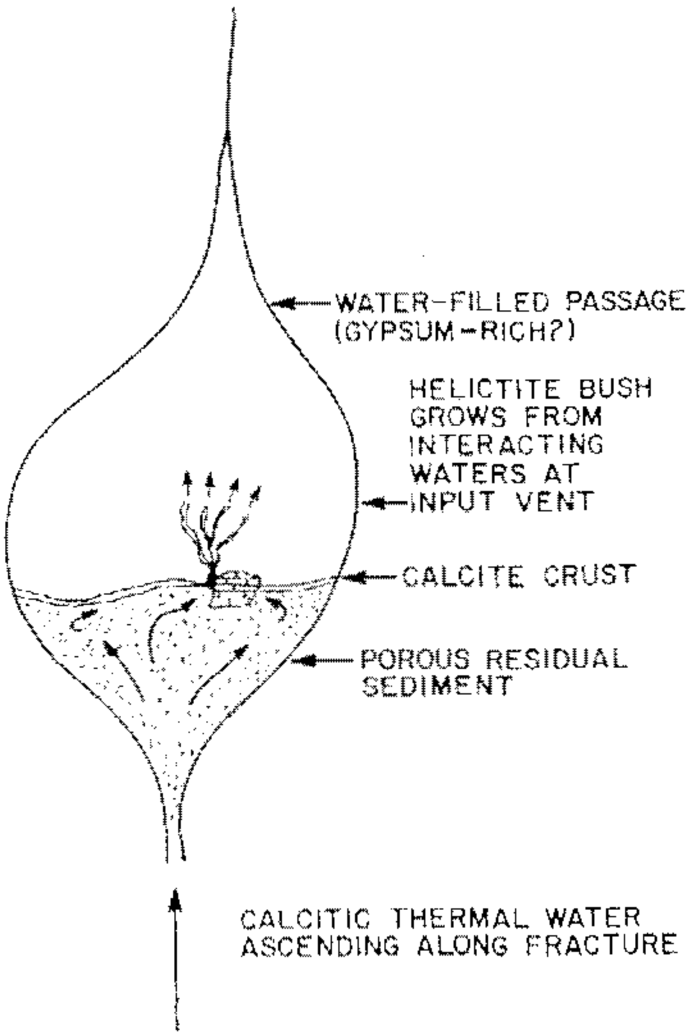
Points 1 through 5 in the above observations, though not impossible in a subaerial model, are simpler to account for in a subaqueous one. Point 6 appears to be explainable only by subaqueous growth. Accordingly, it seems highly probable that the helictite bushes in this section of Wind Cave grew underwater before the water table fell beneath their levels (this conclusion would be strengthened if diving were to find that such bushes continue to substantial depths below the present water table). Speleologists in the past had not seriously considered this possibility because they had neither seen helictites growing underwater nor thought of any plausible means by which this might happen. What mechanisms, then, could allow for the growth of subaqueous helictites and for the differences between the Wind Cave and Lechuguilla forms?

In both cases, they appear to be composed of calcite. The Lechuguilla helictites, unlike those in Wind, are usually unbranching and grow erratically inward and downward from the walls of shelfstone-rimmed pools, never turning above the shelfstone level. They are finely crystalline, with uniformly circular cross-section and relatively uniform diameter usually between 1 mm and 8 mm. They have tiny, regular central canals. In all 14 known localities, partially-dissolved gypsum blocks or crust lie upslope from the helictite pools.

I hypothesize that in Lechuguilla Cave, mixing of gypsum-enriched stringers of water into the calcite-saturated pools has triggered growth of helictites at the mixing points where calcium ions are in excess, via the so-called "common ion effect." I speculate that similar mixing chemistry may have been involved at Wind Cave, but with variations in the mechanics to account for the different morphologies.

The Wind Cave helictite bushes have intricate, usually ascending dendritic branching (possibly to a degree unknown in helictites from any other cave), with branch dimensions varying from needle-thin (as in terminal segments of Emperor Maximus) to 25 mm or more wide. They are relatively irregularly and coarsely crystalline, with individual crystal domains apparently to 25 mm or more in length in those not too overcrusted to see the basic structure. Cross-sections vary from circular to angular or flattened into a strap-like form. The internal canals vary correspondingly in shape, with a variety of irregular partitions and obstructions common. These blockages are probably the cause of the numerous bifurcations that result ultimately in the elaborately arborescent pattern.

Their growth up from floors of passages at that time beneath the water table, and the absence of gypsum blocks, imply differences in mineral sources from those in the restricted shelfstone-pool environments in Lechuguilla.



There are at least two instructive parallels to the Wind Cave situation: the cave "geysermites" reported in *Cave Minerals of the World* (pp. 41–42); and the recent discovery of tubes extended from the sea bed where submarine springs vent in ocean floors.

Geysermites are interpreted as forming "from upwelling, thermal water," but it is not clear whether the geysermite cones were submerged when formed. Hill and Forti (1986) do not report any specific investigation of the chemistry of geysermite development, but hypothesize (p. 42) that "water rich in dissolved carbon dioxide releases carbon dioxide gas as the water ascends into the cave . . . this release . . . causes the precipitation of calcite." This model would work only if the geysermite were surrounded by air into which the CO_2 could disperse. However, substantial flow of upwelling water in the enclosed cave environment would be likely to be associated with flooding and submergence of the exit point, even if it was not already at a water table—a situation similar to that I propose for the Wind Cave helictite bushes.

The suboceanic spring-vent tubes were discovered on the sea floor by deep-diving vehicles. Those initially sampled (e.g., Rona, 1986) were composed of sulfide minerals and had grown where mineralized submarine hot springs ("smokers") interacted with seawater. Subsequently (Ritger et al., 1987), similar "chimneys" up to 1 m high—but composed of carbonate minerals—were found where methane-rich seeps reacted with seawater. The chemistry, even in the carbonate case, may not be close to the Wind Cave analogue, but the existence of submarine "chimneys" certainly establishes that rising fluid plumes can create ascending tubular mineral structures in a subaqueous medium.

It is likely that the more delicate and complex Wind Cave deposits are also creations of former thermal water rising along fractures underlying this major axial passage of the cave. Higher temperature in the entering water than in the ambient water would help account for the ascending growth tendency of most helictite bushes. In mechanics of development, Wind Cave helictite bushes are probably more akin to geysermites and submarine "chimneys" than to either ordinary helictites or the non-thermal subaqueous helictites of Lechuguilla Cave.

A related case has been reported in the speleological literature: Peck (1979) described small tubular speleothems, up to several inches long, some of which had large central canals and which Peck believed had been created by injection of ascending fluid into geode-like phreatic caves. Peck defined the growths as subaqueous "helictites" and "stalactites" (notwithstanding that most of the "stalactites" had grown upward). Like some submarine chimneys, these speleothems were composed of sulfide minerals, and it would probably be more appropriate to classify them as a spelean variant of the marine "smoker" phenomenon.

Although the physical characteristics of subaqueous helictites differ between Wind and Lechuguilla Caves, the chemistry of deposition may have been related. It is possible that Wind Cave helictite bushes were created, like those in Lechuguilla, by interaction between calcium bicarbonate- and calcium sulfate-rich waters. The distinctions between the helictite geometries in the two caves might mean that the relationship between the ambient and inflowing waters in one cave was in mirror image in the other.

In Lechuguilla, calcitic water bodies have been invaded by lesser stringers of sulfate-bearing seepage. In Wind Cave, study by Margaret Palmer (1988) indicates that the dolomitic bedrock surrounding Wind Cave originally contained zones of gypsum or anhydrite which were subsequently dissolved or replaced by silica and calcite. If these evaporites had not been fully removed from the Pahasapa at the time of helictite-bush growth, the ambient groundwater might then have been high in gypsum. The intruding thermal plumes, coming from lower strata, might have been rich in calcite but not gypsum. This would enhance the tendency toward ascending helictite growth; calcite is far less soluble than gypsum, so the less gypsiferous solution should (temperature differences aside) be less dense than the surrounding gypsum-rich water and would therefore rise through it. The comparatively large size of the Wind Cave helictites and of their feeder canals, with respect to those in Lechuguilla, may reflect a faster fluid input rate in the Wind Cave situation, though the larger crystal size in Wind Cave may imply slower growth of the speleothems themselves, perhaps implying less intense reactions in the Wind Cave case.

Fig. 2 illustrates the proposed mechanism of helictite-bush growth. A phreatic passage is flooded with water which is presumed to have dissolved gypsum from the surrounding bedrock. Thermal, calcite-rich water rises into porous residual floor sediment from underlying fractures. At the sediment surface, the two waters react via the common ion effect to create a calcite-crust barrier. This directs venting preferentially to weak points in the crust, where vent tubes in the form of helictite bushes then extend out from the exit point.

Certain anomalies in the growth of a minority of helictite bushes do pose challenges to the ascending-water framework I propose. Especially problematic is the famous Emperor Maximus, the largest known bush complex, in which scores of intertwined branches, growing downward from a ceiling joint, extend 2 meters or more from the ultimate point of origin. After examining Emperor Maximus in its context, I believe its unusual orientation is attributable to peculiarities in the local "plumbing." Within a few meters before Maximus, many smaller bushes grow upward from floor crust in the normal way. Maximus itself is situated where the main passage pinches into a joint. If a thermal plume had been rising along that joint beyond the end of the open passage, it would have found no floor crust to issue from, and would have been diverted laterally to emerge at the most open level of the joint, in this case along the ceiling. The branches of Maximus are also thinner-walled and more slender than in most others, and if temperature gradient was the primary determinant of growth direction, Maximus may have equilibrated with surrounding water faster than most bushes, allowing it to grow atypically downward.

Near Calcite Lake, a few smaller bushes also grow from ceiling joints and wall crust, in association with more numerous floor bushes; the above considerations probably apply to these as well. The same area has a more puzzling phenomenon: interspersed with typical bushes on floor crusts are a number of cryptic stalagmite-like objects, cylindrical or parabolic with round tops, averaging 75–100 mm in diameter by 30 cm high, from whose irregular surfaces bristle small, tentacle-like, downward-angling helictite-bush arms up to 10 cms long. These are almost certainly not true stalagmites; none have stalactites above, nor do they correlate with obvious ceiling drip points. They are apparently another subaqueous form created by water rising from the floor, but I have no explanation for their stalagmitic symmetry.

In certain passages, especially off the Garden Gate area, groups of helictite bushes show consistent deflections, usually in the downslope direction, as if influenced during growth by currents in the surrounding water (in one case the direction is reversed behind the inner angle of a corner, where there was probably an eddy). The deflections are generally consistent with fossil ripple marks near Calcite Lakes, which appear to indicate flow in the downdip direction.

If I am correct in proposing that these are subaqueous speleothems, many factors beyond the scope of my observations may have been involved, and my chemical scenario is offered only as a speculative possibility pending analytical study. Ed LaRock intends to do sampling and analysis of broken pieces to confirm the composition of the helictite bushes and to elucidate the temperature and geochemistry of development. This should be rewarding; understanding the origin of helictite bushes is not only interesting in itself, but is important to more accurate knowledge of the history of events in Wind Cave.

REFERENCES

Hill, C. and Forti, A. *Cave Minerals of the World*. National Speleological Society, Huntsville, AL. 238 p. 1986.

Palmer, A. *An Ancient World Beneath the Hills: Wind Cave*. Wind/Jewel Caves Natural History Association, Hot Springs, SD. 49 p. 1988.

Palmer, A. *The Geology of Wind Cave*. Wind/Jewel Caves Natural History Association, Hot Springs, SD. 44 p. 1981.

Palmer, M. "Influence of Former Evaporites on South Dakota Caves." *Abstracts NSS Convention Program 1988*. National Speleological Society, Huntsville, AL. 1988, p. 31.

Peck, S. "Stalactites and Stalagmites of Marcasite, Galena and Sphalerite in Illinois and Wisconsin." *NSS Bulletin*, Jan. 1979, p. 27–30.

Ritger, S., Carson, B., and Suess, E. "Methane-derived Authigenic Carbonates Formed by Subduction-induced Pore-water Expulsion Along the Oregon Washington Margin." *Geological Society of America Bulletin*, Feb. 1987, p. 147–156.

Rona, P. "Mineral Deposits from Sea-floor Hot Springs." *Scientific American*, Jan. 1986. p. 84–92.

Shafer, D. "The Geology of Wind Cave National Park." *Rocky Mountain Caving*, Autumn 1988, pp. 23–25.