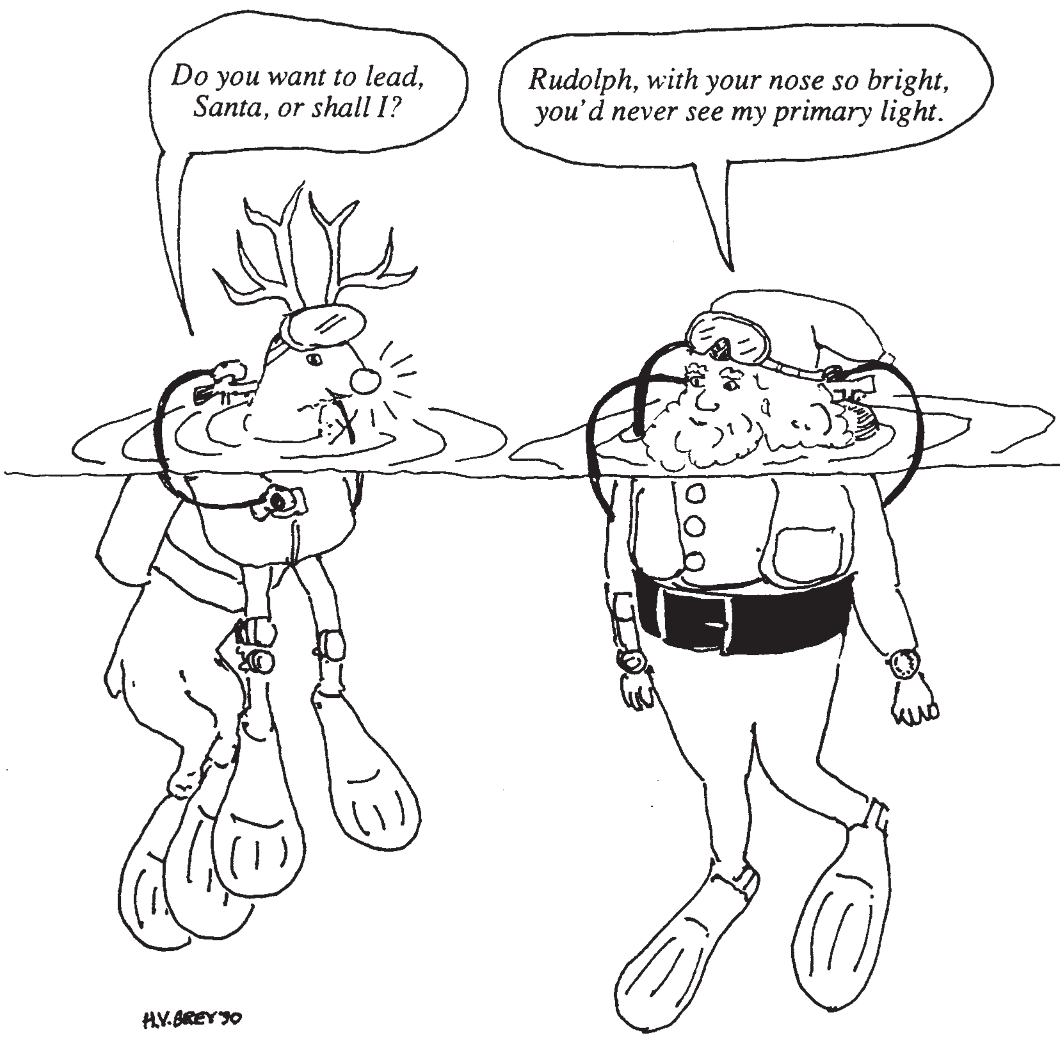
UNDERWATER SPELEOLOGY

NATIONAL SPELEOLOGICAL SOCIETY • CAVE DIVING SECTION VOL 17 • NO 6

An Important Safety Tip from Santa . . .



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Magazine Submissions — We welcome all news items, articles, Letters to the Editor, photos, slides, cartoons, and other items of interest or importance to the cave-diving community from all members, subscribers, and other interested parties. They should be sent directly to the Editor (see address on left column). We can also use text processed in most IBM-compatible and some Macintosh formats. (Please contact the Editor directly for details and arrangements.)

Advertising — The NSS-CDS Board of Directors has approved the reinsitution of paid commercial advertising for *Underwater Speleology*. Please contact the Editor for information and arrangements (see address on left column).

The NSS and Cave Diving — Founded in 1941, the National Speleological Society joins together thousands of individuals dedicated to the safe study, exploration, and conservation of caves. The first cave-diving information ever published in the United States was in a 1947 *NSS Bulletin*. In 1948, NSS divers were responsible for the first cave dives in the United States using scuba. Prior to 1973, cave diving within the NSS was on a purely local level. That year saw the creation off the NSS Cave Diving Section to provide a vehicle for information exchange. Today, with over 500 members, the Cave Diving Section promotes safe cave diving through semi-annual workshops; cavern- and cave-diving training programs; warning-sign installations; search, rescue, and recovery through the National Cave Rescue Commission; cave exploration and mapping; several texts and publications on cave diving; and the bimonthly magazine, *Underwater Speleology*.

NSS Membership — The National Speleological Society welcomes the interest of anyone who has a sincere concern about the safety, study, exploration, and conservation of caves, wet or dry. You may join the NSS either by writing directly to its main office (National Speleological Society, Inc., Cave Avenue, Huntsville, AL 35810) or to the Cave Diving Section. Annual membership is $25.00 and includes subscription to the NSS's monthly magazine, *NSS News*, as well as voting privileges and discounts on publications and conventions.

CDS Membership — As a sub-organization or "section" of the NSS, the Cave Diving Section is subject to the bylaws and ethics of the NSS. Membership in the Cave Diving Section is open to anyone who is a member in good standing of the NSS. Annual membership is $5.00 per year and includes subscription to the CDS's bimonthly magazine, *Underwater Speleology*, as well as voting privileges and discounts on publications and workshops.

Subscription — If you do not wish to join the NSS and CDS, but would like to keep current on cave-diving events, exploration and technology, you are invited to subscribe to *Underwater Speleology* for $15.00 per year.

ACCIDENT CLOSES PEACOCK SPRINGS TO SOLO CAVE DIVING

As a direct consequence of the unfortunate Nov. 4, 1990 drowning of certified cave diver Darden Davis of Orlando, Florida, while solo diving in the upstream tunnel of Olsen Sink in the Peacock Springs Cave System in North Florida, the Park authorities at Peacock Springs State Park have instituted a new rule prohibiting solo cave diving in the Park environs.

Information provided to the Editor on the accident is still largely speculative and far from complete. However, at this point it appears that the deceased, who was apparently fairly well known and well liked within the North Florida cave-diving community, and known to have been quite familiar with the section of cave he was diving, ran out—or thought he had run out—of air in the upstream tunnel approximately 200′ north of Olsen Sink. He was reported to have been wearing dual-manifolded 104cf doubles and an 80cf stage bottle (or "buddy bottle"). The stage bottle was determined to be empty but the doubles contained 1200psi of air.

The valve to the regulator equipped with the SPG (the primary regulator) had been turned off, presumably by the deceased, probably because of a second-stage free-flow malfunction that was discovered upon later testing of the equipment.

It has been suggested that Davis might have somehow bumped the other valve handle (to the backup regulator) on the cave ceiling, causing it to shut itself off, or that he might have only cranked it open a slight ways upon initial setup, and that as tank pressure dropped, the aperture was no longer large enough to properly supply the backup regulator.

It is hypothesized that, under the stress of breathing from a poorly performing backup regulator, the deceased may have forgotten about having turned the primary regulator off (which, of course, would cause his SPG to read zero). He might have concluded that a dead SPG and a hard-drawing regulator meant that his doubles were nearly dry, and thus have resorted to his stage bottle.

There were no other evidences of equipment malfunctions, light failures, bad air, etc., and the relatively shallow depths of the tunnels (60-70′) probably rule out narcosis as a significant contributing factor. There is no concrete evidence to indicate what kind of air planning was used for the solo dive, what the starting pressures of the 104's or 80 were, or in what proportions or fashion the stage bottle was intended to backup the primary air supply.

Park Ranger Carmen Bales wrote later that she had encountered Davis earlier in the weekend and had tried to dissuade him from solo diving, but to no avail; that under the existing Park regulations she had no authority to stop him and could only ask to see his certification card.

Also, at the time the news of Davis' death broke there were wild rumors regarding aspects of his personal life that might have unduly influenced him during his planning and execution of the dive; these rumors are unsubstantiated; and the coroner has ruled it an accidental death. Darden's cave-diver friends are invited and encouraged to send in memoria for publication if they so desire. ■

ERRATA

A couple of errors and omissions should be noted for *UWS* Vol. 17, No. 5. The Editor would like to express apologies to Mikhail Aljukov of the U.S.S.R. for erroneously attributing his delightful Russian cartoon of the "philosophical cave monster" featured on p. 19 of the last issue, to his friend, Vladimir Kisseljov. Thanks are in order, though, to Vladimir for sending the cartoons in. Another of Mikhail's superb cave-diving and sump-diving cartoons is featured on p. 12 in this issue, and more are to come next year.

The Editor would also like to apologize to Dr. David Sawatzky for failing to give him proper credit for the portion of his map of the Ottawa River Cave System, which appeared on p. 7, used to illustrate the article, "Adventures in Warning Sign Installation," by John Reekie. Dr. Sawatzky's excellent in-depth article on the exploration and mapping of the Ottawa River Cave System, complete with a brand-new version of the most up-to-date map, promised for this issue, will appear in next the issue to give us just a little more time to verify revisions made to the two different articles submitted. But it's well worth the wait, as the map, drawn by Dr. Sawatzky, and comprising a total surveyed length of 2802m, represents a staggering amount of manhours under truly rigorous conditions. The contributing divers are: D. Sawatzky (115 hrs.), S. Lennox (36 hrs.), R. Browning (25 hrs.), K. MacGregor (25 hrs.), A. Shamess (24 hrs.), J. Reekie (18 hrs.), I. Mitchell (9 hrs.), and S. Drdla (5 hrs.). ■

WORKSHOP

Plans for the Winter Workshop, "Looking to the Future," slated for the weekend of Sat. - Sun., Dec. 29-30 at the Branford High School in Branford, Florida, are proceeding nicely. Additional Speakers have been scheduled, including past Section Chairman Jeff Bozanic on Cave Diving in Australia, and Jim King on the Mixed Gas Explorations of Eagle's Nest.

Pre-registration forms were mailed out with *UWS* 17:5 and should be returned as quickly as possible. Registration with complimentary coffee and doughnuts begins at 8:00 a.m. Saturday, with the program beginning promptly at 9:00 a.m. For more information, contact the Workshop Chairman, Jim Gabriel: (home) 904-454-8571, (work) 904-454-3556. ■

CDS BOOTH AT DIVE SHOW

by Pete Butt (NSS #24215)

TNSS-CDS again participated in the 1990 International Dive and Travel Show, held on Oct. 11-14 at the Orange County Convention Center in Orlando, Florida. The Show provided the Section with a service booth on the main floor at no cost. This show, the third one held, is a major Florida and regional event for the diving consumer, professional, and businessperson. The response from show attendees during the two "trade-only" days and the following two open-to-the-public days was superb.

Surrounded by manufacturer and travel booths, our eye-catching booth, arrayed with color-photo enlargements of cave-diving scenes, cave maps, and the Section logo, captured its share of attention. A variety of cave-diving videos were continuously shown, catching the interest of those passing by. Section members staffing the booth answered many questions about cave diving, while passing out several hundred Cave Diving Safety Brochures, along with membership information and forms. Many of the individuals stopping to talk with us were instructors, store owners, and dive leaders. Section publications and T-shirts were on display and for sale.

Booth organizers and BOD members Lee Ann Hires and Pete Butt would like to thank Tony Martin, Jim and Corbin Cunningham, Barb Smith, Scott Isberner, and Kevin Christiansen for their help in staffing our display at this important event. The Section also extends its thanks to FADO, the 1990 IDTS Committee, and William T. Glasgow, Inc., Show Management. ■

TARAVANA CAVE: New Zealand

by Jeffrey Bozanic (NSS #22532)

The potential for cave diving in New Zealand has not been fully developed. In fact, the surface has barely been scratched. During recent travels to the country, information about potential cave-diving sites was collected, and a few preliminary dives conducted to examine possibilities. Taravana Cave was the most significant of these sites.

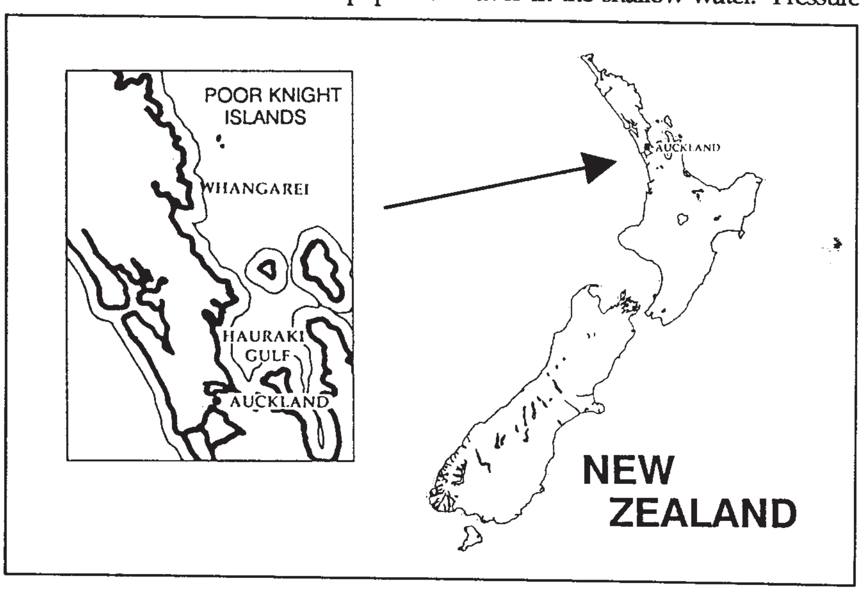
Taravana Cave is located in the Poor Knights Islands Marine Reserve off the coast of the North Island. The marine reserve was established in 1981 to protect the marine life around the islands. Because of this, and the clear visibility, the reserve is one of New Zealand's popular diving locations.

The cave floor begins at a depth of approximately 120′ near the southern end of Tawhiti Rahi Island. It appears to follow a jointing fracture in the island. Although the cave has been reported as a lava tube in other articles, it has none of the classical features associated with lava tubes. The cave extends 521′ before pinching out in a vertical crack. The total length of the cave is 800′.

The water temperature was approximately 70° F when visited, during the local late-summer season. Visibility was about 60′. Marine life outside the cave included low, dense kelp cover, and a variety of perch, wrasses, urchins, and other open-water fauna. No cave-adapted fauna was seen. Overall, the diving was very reminiscent of diving California's Channel Islands.

Several other caves in the Poor Knights were also examined. Riko Riko cave was large enough to motor the large dive boat into while diving the site. Several smaller sea caves populated the shallow subtidal shoreline.

One of these was very interesting. The cave started at 40fsw, extended about 150′, and ended in an air bell at the end. The swell was coming in, and actively compressing the air at the back of the cave. A drysuit was worn for the dive, which could be felt squeezing and unsqueezing the author's body as the waves came and receded. The ears were also pulsating with the pressure waves in the shallow water. Pressure



depth was changing by 5′ as the 1-2′ swells passed. No attempt was made to surface in the air bell because of the pressure-wave compressions. Since the water was being compressed by 5′, it was hypothesized that the air compression was probably many times that—not at all healthy for intact ear drums!

There are also references to many other potential cave-diving sites elsewhere in New Zealand, most notably at the northern end of the South Island.

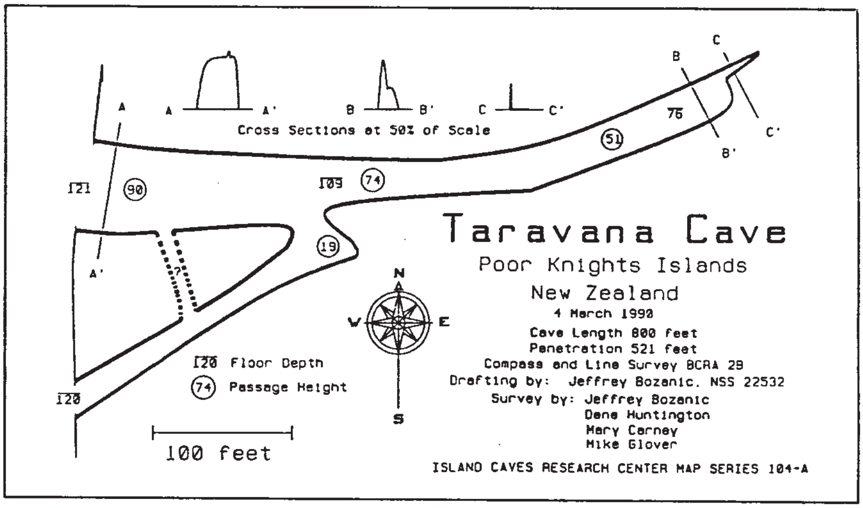
The city of Whangarei is the best place from which to reach the Poor Knights. Located about two hours north of the capital city of Aukland, a regular bus schedule makes it convenient to get there. All diving during this trip was organized by the Sub Aqua Dive Centre. The owners, Dene and Carol Huntington, were very helpful in providing equipment and modifying prior plans to allow the time for the survey of Taravana to be completed. The diving was done from the *Pacific Hideaway*, a commercial dive boat. Again, the captain of that vessel, Bryan Bell, was also most supportive of the activities.

Most airlines will allow one stopover during long international flights. For any divers planning a visit to Australia's Great Barrier Reef, or their caves, it would be a simple logistical exercise to debark in Aukland for a few days to visit the Poor Knights. The following contacts will assist in gathering information for any such diving activities:

Dene & Carol Huntington
Sub Aqua Dive Centre
11 Clyde Street
Whangarei, New Zealand
Tel-(089) 481-075

Bryan Bell
Pacific Hideaway
RD 3
Whangarei, New Zealand

Poor Knight Islands Reserve
Dept. of Conservation
Whangarei District Office
P.O. Box 842
Whangarei, New Zealand
(089) 480-299



About the Author: Jeff Bozanic has been cave diving since the early 1980's and has done underwater exploration literally all over the world—from California, Mexico and the Caribbean, to the Middle East, the Antarctic, Australia, and the exotic islands of the far Pacific. He is intensely involved in diver education and is presently serving on the NAUI Board of Directors. He is an NSS Cave Diving Instructor, a past NSS-CDS Chairman, and was the Workshop Coordinator for two of our most successful workshops. Jeff has been a regular lecturer at NSS-CDS workshops, and has written extensively on cave diving for *Underwater Speleology*, as well as numerous other diving publications and books.

[Island Caves Research Center, Inc.
Safety and Education Series, No. 28.] ■

MISSING UWS 17:3 OR 17:4?

The Editor has received numerous inquiries from paid-up members and subscribers in both the United States and Canada, who have received *UWS* 17:5, but not 17:3 and/or 17:4 (and even a few paid-up members who never received 17:1 or 17:2).

Concerning 17:3 — Upon requesting copies of these back issues to send to these agrieved members and subscribers, the Editor was told that an insufficient number of copies of 17:3 were shipped from the printer in California to Miami to fulfill the scheduled mailing, and that apparently no attempt to procure additional copies of 17:3 to complete the mailing was ever made. The why's and wherefore's do not much matter now; the important thing is to get these fine, interesting issues to the people who paid to receive them. The new Editor has had photo copies of 17:3 made and will send them upon request to those who did not receive them. Call the Editor (or more likely, the Editor's answering machine) at 813-484-7834 or drop a post card to: H.V. Grey, POB 12, Nokomis, FL 34274-0012.

As to 17:4 — In hopes of being able to insert the Workshop pre-registration form in this issue, it was diverted to the new Editor's printer in Venice. It did not arrive until Nov. 15, several days after the pre-registration form, which was supposed to have gone out by Oct. 15, had already been inserted and shipped out in the first available issue, 17:5. 17:4 has been shipped and most people should already have received it by the time they read this. ■

GEAR LOST

Lost: One English Engineering 400-watt Video Light. Large clear battery case with blue and black 36-volt battery pack. Two hose clamps attach blue 1" web to case with a brass boat snap at each end. Black cord connects to a test-tube-type head with H-1-type 400-watt bulb and adjustable reflector. Reflector is faceted, and there was blue tape on the handle.

Unit "went missing" about September 18 at Otter Springs. $100.00 reward for return.

Karst Productions: 904-454-3556.

Personal ads for Lost & Found, Gear Wanted/For Sale, etc. will be printed at no charge. Contact the Editor. ■

PHREATITE: a Speleothem Formed in Phreatic Limestone Conduits

by Harris W. Martin, Ph.D. (NSS #26771)

What we cave divers think of as "goethite" is not goethite. True goethite (α-FeOOH) is a pure, oxidized iron mineral with a particular crystalline structure (American Geolo-gical Institute, 1976). Data collected thus far indicate that the material cave divers call goethite is a mixture of minerals; thus, geologically it is a rock, not a mineral. I propose that we call this rock "phreatite," from the word *phreatic*, because it forms underwater in completely submerged phreatic conduits in limestone. Another possible name is "peacockite" because this rock type is so common in the Peacock cave system and can be easily studied there. For the remainder of this article it will be referred to as phreatite.

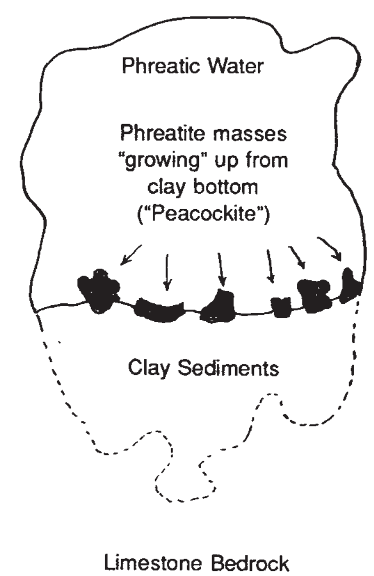


FIG. 1. Cave-bottom phreatite formed on clay sediment substrate. This morphological type is very common in the Peacock cave system and appears to be limited to low-flow phreatic cave conduits.

Phreatite is a dark brown mineral formation that is common in many of the subaquatic limestone cave systems in Florida. Since phreatite forms in caves, it is a speleothem. The most spectacular speleothems, such as stalactites and stalagmites, are found in caves that are or were air filled in whole or in part (vadose caves). Phreatite, however, forms underwater. There are relatively few types of speleothems formed entirely underwater. Phreatite appears to be the only common consolidated speleothem in the subaquatic caves of the Suwannee River basin in North Florida.

These speleothems exist on several types of substrate. They can be odd-shaped chunks of material that appear to "grow" up from the clay sediments on the floors of many subaquatic caves (Figure 1). In portions of some caves they form a "crust" or "rind" approximately 1cm thick on the limestone ceiling or wall (Figure 2) (Li et al., 1979; Rupert and Wilson, 1989). They often exist as crusts coating limestone rock fragments littering cave floors (Figure 2) in many sections of the Peacock system, Little River, Devil's Ear, Telford, and other caves. Just downstream from the Beulahland section of the Telford system and in parts of the Peanut Tunnel of the Peacock system, they exist in roughly crystalline forms apparently "growing" down into bottom clays (Figure 3).

Phreatite does not form on loose sand surfaces, but in Madison Blue, where phreatite is not very common, it tends not to be solid phreatite, but exists as coatings on soft, rust-colored sandstone (Figure 4). The phreatite found in the Thunderhole system is sufficiently unusual to justify a separate article to be published in future. At the top of the chimney in Thunderhole,

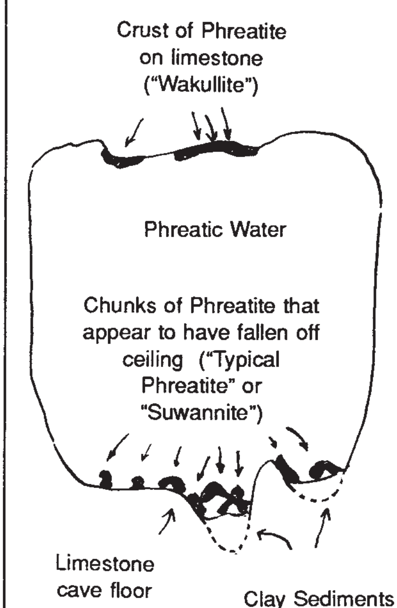


FIG. 2. Crust or rind phreatite found on concave ceilings and walls. This morphological type is found in Little River, Wakulla, and some blue holes of the Bahamas. Chunks of phreatite on solid rock floors are common in Little River and Telford, have been observed in phreatic caves in Texas and northern Mexico, and appear to be concentrated in areas of high flow.

phreatite seems to ooze from two strata in the limestone (Fig. 5). On the lower of these two strata, phreatite forms only on exposed shell fossils. This "oozing" phreatite appears to be solid phreatite to its core. However, many phreatite rocks found on cave bottoms contain a core of white material resembling soft limestone.

Usually the surface texture of phreatite formations is an irregular or smooth "bubbly" or "bumpy" pattern. These "bumps" are approximately 1mm wide (smaller than the "bumps" on the palms of reef diving gloves).

This speleothem has been observed

in Wakulla Spring in the Panhandle of Florida (Rupert and Wilson, 1989), in Lucayan Caverns, Grand Bahama Island (Li et al., 1989), in the Naharon cave system in Quintana Roo province of Mexico (Madden), in a cave near Mante in Tamaulipas province of Mexico (Walton), and in a cave in Kendal County, Texas (Bowden). All of these caves are entirely submerged.

Cave divers have collected phreatite samples from Peacock, Telford, Little River, Madison Blue, Emerald Sink, Thunderhole, and other cave systems. These samples have been sent out to various labs for analysis by several methods. Preliminary results have come back from one lab. Scanning electron microscopy (SEM) was conducted on the surface of a phreatite sample from the wall of the Black Abyss Tunnel in Emerald Sink. The results of this SEM analysis indicate that the material on the sample surface contained 48-72% Iron, 5-9% Manganese, 5-9% Aluminum, 3-6% Calcium, 1.4-2.6% Silicon, 1.3-2.0% Sulfur, and 0.8-1.4% Phosphorus, all expressed on an elemental basis.

A protrusion of phreatite was broken open to scan the white mineral material underneath the phreatite. This white material was not limestone but appeared to be a mixture of alumino-silicate clays, iron compounds, and other minerals. It contained 20-36% Aluminum, 18-39% Silicon, 9-17% Iron, 2-4% Calcium, 1.2-2.3% Manganese, 1.3-2.3% Magnesium, 0.5-1.1% Potassium, and 0.1-0.5% Phosphorus. These data indicate that phreatite is not a pure mineral (thus it cannot be goethite), but is likely a mixture of ferrous and ferric iron hydroxides and oxides; along with manganese oxides; calcium, iron and manganese carbonates; alumino-silicate clays; and inclusions of iron, calcium, and aluminum phosphates; and iron and manganese sulfates or sulfides.

The colors observed in phreatite—dark brown to black and sometimes yellow-brown—indicate that it likely contains some goethite. Goethite is the most common iron mineral found in most surface soils, especially in calcareous hydromorphic (waterlogged) soils. Another iron mineral that may occur in phreatite is ferrihydrite ($Fe_5HO_8 \bullet 4H_2O$ and/or $Fe_5(O_4H_3)_3$) (Schwertmann and Taylor, 1977).

The possible role of bacteria in the formation of this material should be considered. In reducing environments in submerged sediments and subsoils, chemoautotrophic bacteria are often present. Chemoautotrophic means that these bacteria do not need carbon or light for an energy source. They obtain energy by converting chemically reduced substances such as iron, manganese or sulfur into more oxidized states.

The action of such bacteria might account for the presence of oxidized minerals in a (relatively) reducing environment. Bacteria that may be in-

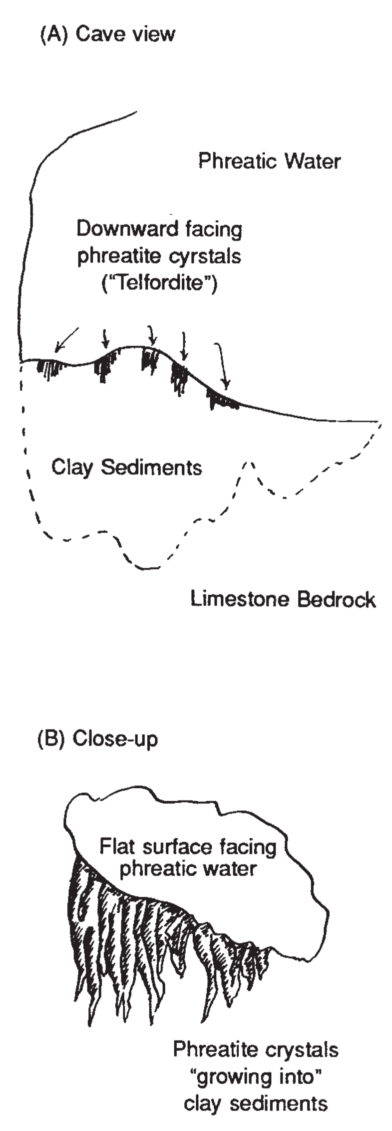


FIG. 3. Crystalline phreatite oriented into bottom clay sediments and away from phreatic water. This morphological type is uncommon but has been observed in Telford and Peacock. (A) Cave view, (B) Close-up.

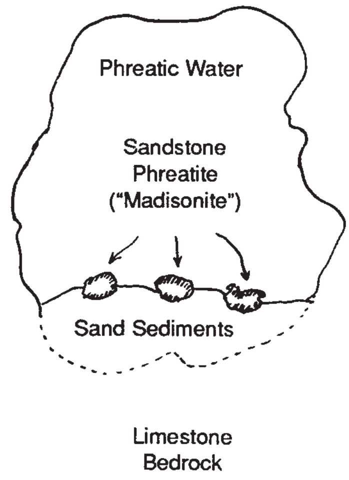


FIG. 4. Sandstone phreatite. Observed only in Madison Blue cave system thus far. This phreatite encrusts soft sandstone rocks resting on/in sand floor sediments.

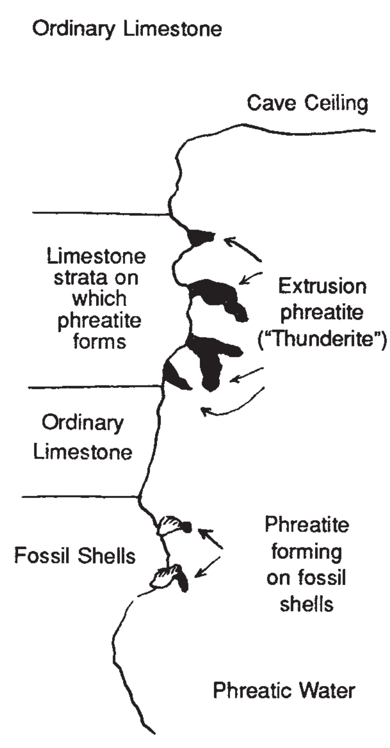


FIG. 5. Unusual phreatite formations observed in Thunderhole cave system.

volved in phreatite formation are not likely to be obligate anaerobes, but would more likely be microaerophilic or facultative anaerobes. The carbon source for such bacteria could be dissolved CO_3^-, dissolved organic compounds in groundwater, or suspended and dissolved organic compounds in intruding surface (vadose) waters.

Brock et al. (1984) stated, "Ferric iron reduction is very common in waterlogged soils, bogs, and anaerobic lake sediments [which are common in Florida]. In many waterlogged soils, the ferrous iron so formed is leached out of the soil. Movement of iron-rich groundwater from anaerobic bogs or waterlogged soils can result in the transport of considerable amounts or iron. Once this iron-laden water reaches aerobic regions, the ferrous iron is quickly oxidized spontaneously and ferric compounds precipitate, leading to the formation of a brown deposit. The overall reaction of ferrous iron oxidation can be represented as follows:

$$Fe^{2+} + 1/4\,O_2 + H^+ \leftrightarrow Fe^{3+} + 1/2\,H_2O \quad (1)$$

$$Fe^{3+} + 3OH^- \leftrightarrow Fe(OH)_3 \text{ precipitates} \quad (2)$$

"Although ferric iron forms very insoluble hydroxides, some ferric iron can be kept in solution in natural waters by chelation with organic materials. . . . If an organism is present that can oxidize the organic chelator, then the iron oxide will precipitate. This is probably a major mechanism of iron precipitation in many neutral pH environments." (Brock et al., 1984). The subaquatic karst cave (phreatic conduit) is an environment of neutral to slightly basic pH; thus this may be a bacterial mechanism of phreatite formation. Such a deposition process could act as a weathering agent on the surface of cave limestone because, according to Brock et al. (1984), the oxidation of ferrous iron leads to an acidification of the medium.

Note that Reaction 2 consumes 3 OH^- ions for each H^+ ion consumed in Reaction 1. Whether FeOOH (goethite), $FeCO_3$ (siderite), or FeS_2 (pyrite) is the stable solid phase depends on the electron (redox) potential and the CO_2 and sulfur concentrations of the water. The type of iron compound formed is also a function of the "activity" of the various iron compounds in solution. The "region" of $FeCO_3$ stability (on a thermodynamic mineral equilibrium chart) increases with increasing P_{CO2} (partial pressure of CO_2) (Bohn et al., 1979).

The iron mineral ferrihydrite is often rich in organic carbon impurities (Schwertmann and Taylor, 1977). Though organic and carbonate carbon contents of phreatite have not yet been determined, if phreatite is precipitated in conjunction with bacterial oxidation of ferrous iron, phreatite is likely to contain some organic carbon. According to Schwertmann and Taylor (1977), waters percolating through acidic surface (soil) horizons carry organic compounds which cause the dissolution of iron in the soil. On exposure to oxidation conditions, such as in drainage ditches or springs, the soluble (ferrous) iron compounds are attacked by microorganisms and the oxide is rapidly precipitated.

Further crystallization is often prevented by the extensive adsorption of environmental impurities, particularly organics, due to the high surface area of the precipitate. Eventually, ferrihydrite formed in this manner will transform to a more stable crystalline form of goethite (Schwertmann and Taylor, 1977). It is possible that semicrystalline forms of phreatite (Figure 3) are formed as a result of partial transformation of impure ferrihydrite to poorly formed impure goethite crystals. If a good method were available for quantitative ferrihydrite analysis, ferrihydrite/goethite ratios in phreatite could provide information as to the age and formation mechanisms of phreatite.

Iron is much more abundant than manganese in most soils and sediments. It is therefore reasonable that phreatite appears to contain much more iron than manganese. Subsurface water movement can lead to local accumulations of manganese, however, because manganese in soils is more subject to redistribution than iron. Thermodynamic models predict that manganese is more easily reduced and solubilized than iron. Secondary manganese/iron ratios in topsoil have been shown to be a function of near-surface drainage patterns in the vadose zone (McDaniel and Bathke, 1990). Thus it is not surprising that preliminary analysis of phreatite indicated manganese contents as high as 10%.

Hill and Forti (1986) noted that manganese oxides form in streams and pools in [vadose] caves, partly by bacterial action. In environments such as subsoils (McKenzie, 1977) and ocean bottoms (Pettersson, 1954) with localized redox gradients, manganese forms nodules. These nodules often exhibit a concentric layering suggestive of seasonal growth and they contain oxides of both iron and manganese as well as other matrix constituents. Manganese and iron become separated in the geochemical cycle by the oxidation and hydrolysis of iron at values of Eh [redox potential] and pH at which manganese is still quite soluble. However, mixed deposits can form by coprecipitation of manganese with iron oxides (McKenzie, 1977).

On the ocean floor, pelagic deposits of hydrated manganese-iron oxide minerals constitute microscopic aggregates distributed throughout the sediment. In places where the micronodules remain at the sediment surface for a considerable length of time, they grow to macroscopic dimensions, and finally cover parts of the ocean bottom as a pavement (Arrhenius, 1959).

"Pavements" of phreatite have been observed by the author to cover soft bottom sediments in localized areas of the Peacock and Little River cave systems. Sea-floor manganese nodules may form by catalytic (chemoautotrophic bacteria?) oxidation of the manganous (reduced manganese) ion in seawater by a gel film of "ferric oxide hydrate," formed at the bottom surface by discharge (floculation) of the "ferric oxide hydrate" colloid in seawater (Arrhenius, 1959).

The overall reaction of manganese oxidation can be represented as follows (Bohn et al., 1979):

$$2Mn^{2+} + 3.5H_2O \leftrightarrow 2MnO_{1.75} + 3e^- + 7H^+ \quad (3)$$

(where $MnO_{1.75}$ signifies the complex Mn(III-IV) oxides)

This is an acidifying reaction that is likely to promote limestone dissolution under phreatic conditions. The $MnO_{1.75}$ formed is likely to be transformed to MnOOH and/or $MnCO_3$. At pH values greater than 7, the ratio of these two manganese forms is a function of Eh (oxidation-reduction potential) and P_{CO2}. Manganese redox conditions are often less reversible than those of iron so manganese tends to respond more sluggishly to changes in redox conditions (Bohn et al., 1979). Because of such sluggishness in the reverse reaction of manganese oxidation, it is possible that phreatite deposits may become depleted in iron and enriched in manganese as they age. If this is true, techniques might be developed for dating phreatite deposits.

In the "flatwoods" of Florida, manganese and iron have a tendency to accumulate in subsoil layers referred to as spodic horizons. When water tables are at seasonably high levels, karst hydrologic processes may move reduced iron and manganese into shallow aquifers. When this reduced iron and manganese in solution moves through submerged limestone bedrock, solution pH is increased and dissolved CO_2 and CO_3^- play important chemical roles. Thus phreatite may be rich in $FeCO_3$ and $MnCO_3$. According to Doner and Lynn (1977), reducing conditions are required for formation of $FeCO_3$ minerals in which iron occurs in the Fe^{2+} (ferrous) state.

Carbonate components in phreatite are likely to include mixtures of non-hydrated $CaCO_3$ and hydrated $MgCO_3$. Formation of magnesium-calcites occurs by dissolution of existing calcite and dolomite in the parent material, translocation of Ca^{2+}, Mg^{2+}, and HCO_3- ions through the soil profile, and subsequent precipitation (Doner and Lynn, 1977).

Normally, groundwater is low in dissolved oxygen, containing only a few mg kg^{-1} (ppm) O_2 (low Eh or redox potential). This is, however, often enough oxygen to support modest populations of aquatic troglobytes such as catfish, crayfish, isopods, and amphipods. The redox potential of the cave water may be less negative than that of the groundwater entering the cave from surrounding limestone and sediments. Thus a redox gradient may be present at the mineral-water interface. If this redox gradient is sufficient, reduced iron and manganese may oxidize and precipitate spontaneously. In addition or alternatively, this material may be a result of oxidative bio-mineralization by chemoautotrophic bacteria.

It is possible that this material may contain inclusions of suspended detrital or dissolved organic matter. Such organic matter may be complexed with iron, manganese, aluminum, or calcium. It is also possible that during the formation or deposition of this material, suspended colloidal clay minerals and colloidal $CaCO_3$ co-precipitate from the water column and become imbedded in the matrix of the phreatite. In Lucayan Caverns, Grand Bahama Island, Li et al. (1989) proposed that phreatite was formed by saltwater flocculation of iron compounds.

Chemoautotrophic redox bacteria form the foundation of food chains at deep ocean vents and seeps. Portions of the subaquatic cave environment could in this respect be comparable ecologically with deep ocean seeps at the lower edges of submarine continental margins (more so than vents). If this material is formed by or coated with bacteria, however, why have cave-diver scientists not observed isopods and copepods feeding in the vicinity? Perhaps these bacteria are so encased in self-produced mineral deposits, that troglobytic zooplankton and crustaceans are unable to feed on them.

It is possible that most phreatite deposits are not actively forming at present. If phreatite is a bio-mineralization deposit formed by chemoautotrophic bacteria, it is possible that few phreatite deposits are actively forming ("alive") at this time and most are relics of past bacterial activity, thus the lack of grazing by troglobytic invertebrates. Some few phreatite deposits have been observed to be coated with a white film of bacteria. Most are not. It is possible that phreatite precipitation on limestone and clay sediments is an ephemeral process that varies sporadically with changes in chemistry and flow rate of (1) water entering phreatic conduits from surrounding aquifers and (2) water flowing in the phreatic conduits.

We might ask the following questions (among others).

What are the dissolved oxygen, carbon dioxide, and mineral contents; pH; and Eh of the water in the areas where these formations are actively forming; in areas where they occur but formation has ceased; and in areas where they do not occur? Is the "clay" sediment found on many phreatic cave floors composed of alumino-silicate clay minerals or of $CaCO_3$ "mud"? What are the iron, sulphur, manganese, and clay mineral contents of the limestones upon which some of these deposits occur? What is the variation in mineral composition of different phreatite deposits?

Does phreatite form under equilibrium or non-equilibrium conditions? What changes occur in phreatite composition as it ages? Is this material the same as the ubiquitous dark coating on the limestone in subaquatic cave systems such as Devil's Ear, Yana, and Naharon?

Why are phreatite deposits apparently rare in air-filled (vadose) caves? Is phreatite dissolved or eroded away when phreatic conduits enter a vadose stage in their development? What chemical reactions occur when relatively oxidized, organic-rich and mineral-poor tannic river water or percolating surface water come in contact with the relatively reduced and mineral-rich groundwater-limestone interface? Does this promote a dissolution or formation of phreatite? How can we sample bacteria on the surface or in the matrix of these formations? What culture medium should be used?

Phreatite should be analysed with petrographic microscopy, scanning electron microscopy, and X-Ray mineralogy, and analysed for organic carbon and carbonate carbon, total elemental content (by fusion and dissolution with hydrofluoric acid followed by elemental analysis with ICAP), $^{34}S/^{32}S$ ratios of sulfides for evidence as to microbial origin, Mn/Fe ratios, and phosphorous fractionation, and other methods. In the future, perhaps observations can be made on the distribution and age of phreatite, on the mechanism of its formation, and about what can be learned from it regarding the speleogenesis of the cave systems where it occurs. Information thus derived may constitute practical contributions to fields such as biogeochemistry, groundwater hydrology, aquatic chemistry, soil chemistry, subsurface and groundwater microbiology, karst geology, and petroleum geology.

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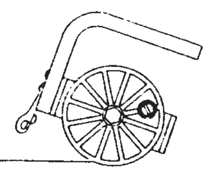
About the Author: Harris Martin is a full-cave-trained diver, holds a doctorate in Soil Chemistry, and is currently a post-doctoral research associate with the Wetland Soils Laboratory at the University of Florida in Gainesville. ■

THE SAFETY LINE



by Wendy Short (NSS #30802), Safety Coordinator South

If you dive with the same buddy all the time, you have probably developed a good, effective tandem system, and have an unspoken understanding while cave diving. But if you dive with a variety of people, you have probably not had a chance to develop the unity in communication that comes with familiarity. Your ability to communicate underwater can dictate the team's safety. Communication starts with being aware of your buddy.

Do you know where your buddy is at all times during the dive? You may not want to stay in close physical proximity every minute, but you should be *aware* of your buddy at all times and be in light contact. You need to be close enough that if an emergency arises, you can then assist him in a matter of seconds.

How can you accomplish this awareness? Always make sure you see your buddy's light near you and respond instantly even if you're not sure he signaled you. The buddy with the weakest light should either be in the middle or in the lead. This is because a weak light beam is absorbed by a more powerful light and cannot be seen. Your light is a tool that serves as more than just a means to light up the cave so you can see. It is a safety feature and a communication device.

Another clue to your buddy's whereabouts is to look for line movement when traveling through small passages.

Do you trust your buddy with your life? You may not have considered your buddy in that respect, but your life may depend on him and his equipment. You should be familiar with and trust his equipment. Completing the S-drill before the dive should assure you of this.

The team's speed of travel is another safety factor that needs to be considered to keep the team together. If one person lags behind, the whole team will have to slow down. Discuss the objective of the dive and set the pace accordingly. Are you on a sightseeing tour where you will want to explore everything at a leisurely pace? Or is a deep penetration the goal where you want to push at a good speed?

When diving in large parties, a periodic head count is a good idea. Don't wait until decompression or surfacing to discover that someone is missing. There should be no reason for anyone to exit the cave without his partners. If the dive is called for any reason, all persons should exit together.

Remember, like your equipment, a buddy must be reliable and accessible. Yet unlike your equipment, if your buddy continues to fail, don't fix him. Get a new one. ■

WHAT HAS GONE WRONG? - Questions for Our Cave Diving Leaders

by Don Landis (NSS #24615)

The recent increase in the accident rate among trained cave divers is of great concern to all. Discussions with many of our leaders in the two organizations (NACD and NSS-CDS) reveal an "accident-analysis-and-be-done-with-it" attitude. Meanwhile the damage to our reputation as a self-regulated sport continues. At first I was content to accept straightforward accident analysis as the answer until the last three deaths among certified cave divers. Now I have to ask questions beyond accident analysis and I'm asking these questions of our leaders, particularly of our training sections.

As I understand it, Accident Analysis was based on the statistical cumulation of facts gathered during the early days of cave diving; reducing these facts to a set of rules that, if adhered to, would result in us all being safe cave divers and not dying in caves. Now I realize that technology and proper training may modify some of the rules over time, such as the rule on deep diving. When I learned the rule it was "Never deeper than 130 feet in a cave"—period! Today, I've seen references to "Never deeper than 130 feet *on air*." This has to do with the acceptance and remarkable safety record of projects such as the Wakulla Exploration project.

There is no doubt in my mind that cave diving is not without risk. One of our former leaders termed it the most dangerous sport in the world. While this is certainly debatable, cave diving is undertaken with a degree of risk that each diver should be made aware of during training. Training is only the catalyst that precipitates safe cave diving. Beyond this training it requires experience to fine tune and develop the skills necessary to be a good safe cave diver.

Now here's a rule that used to be taught in cave diving that I don't hear much about anymore: ***Build experience slowly in cave diving, advancing a little at a time, because slowly gained experience builds a solid foundation for good safe cave diving.***

When was the last time you offered a complete Full Cave course in a week, month, or even six months to open-water divers? Or open-water divers you hardly knew? In any dangerous activity that is taught formally, instructors use a technique of pushing the student to the breaking point to test his survival instincts and demonstrate what that breaking point is in a controlled training session. You combat military veterans know what I'm talking about. How many of you know what the survival level of each of your students is?

It appears to me that our training has improved tremendously over the past five years, bringing standardization to the program. However, this program has made it easier than ever for lesser and lesser qualified individuals to become certified cave divers and cave-diver instructors. And with this standardization a proliferation of certified instructors has surfaced. We seem to be banging out Full Cave and Basic Cave certified divers in droves. Upon questioning I find many of these recently certified divers attempting, with their equally inexperienced buddies, dives that are considered advanced to very advanced in skill requirements.

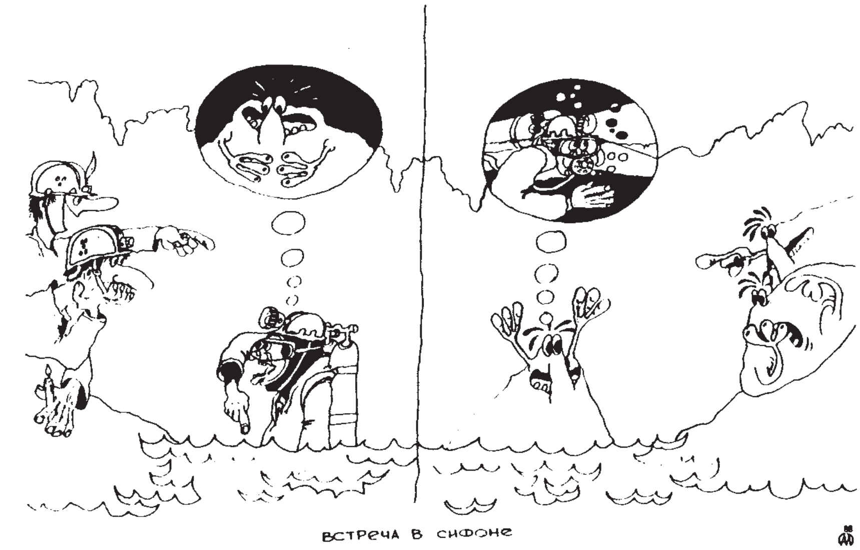
Do all these new instructors have the experience to certify Full Cave? Do they have the experience to test the student to the breaking point while maintaining control? Are they able to train from experience or just academics? How many Full Cave instructors have less than 1000 logged dives in varied cave environments? How many are considered Cave Explorers by their peers? I would not feel comfortable taking a course that is supposed to prepare me for survival in various cave environments unless the instructor could qualify on the above questions. I think it is a good idea to have a multi-level program, but I believe we need to incorporate interim experience level as prerequisite to the next level.

Now there are those of you who will defend the "tourist cave diver" who can't budget the time to get the experience. Should he be held back in his education? This question reminds me of a student I had in an open-water class some years back. After not completing even one lap in the swim test (an entry-level YMCA requirement), he clung to the side of the pool and, heavily out of breath, said, "I can't make it, maybe next week." I said to him that I was sorry but he should do some exercise and practice swimming and try again next semester. He said, "You don't show any consideration for a person's age and just because I'm a little out of shape—" I said, "No! Neither does the ocean."

A little succinct but true. So, I say to all those who cry about not having the time to get the experience to learn cave diving slowly: Find another activity before you become another statistic; and, you instructors, insist on an adequate entry-level of experience prior to training at each level.

A recent issue of *Underwater Speleo* had a picture of Uncle Sam pointing a finger with the caption, "Stay out of our caves." The message was well intended but very pompous and embarrassing to me as a cave diver "living in a glass house." We as a cave-diving community have done an excellent job of getting the word out to the open-water world about the danger of cave diving by those untrained. However, we have been negligent in educating our cave-diving students about the requirements of these rules. Instead, we give these students egos, placing them above their open-water peers. We give them egos that make them want to go do dives that require very advanced skill levels when they only have limited experience and training. Maybe we need to teach a little humility in our courses, be much stricter in who becomes a cave-diving instructor and a cave-diving student.

About the Author: Don Landis has been cave diving since 1978 and has made more than 700 caves. He is a Gold Star YMCA Scuba Instructor, and a PADI Master Instructor and Cavern Instructor. He has taught on a collegiate level and certified more than 500 open-water students. He has produced comprehensive video cave maps of Little River, the Peacock System, Devil's Eye and Madison Blue through his company, Scuba Tech, Inc., and has brought important innovations such as a tank-valve protector to cave diving. ■



"Meeting in the Sump" — *by Mikhail Aljukov*

STATE SPRING ACQUISITION PROPOSAL

The Nov. 5th edition of the *Gainesville Sun* reports that local support is growing for State acquisition of several Florida springs, including Falmouth Springs in Suwannee County and Fannin Springs in Levy County. The Falmouth cave system, located west of Live Oak, flows for 400′ and then disappears into a sinkhole that connects with the Suwannee River via a four-mile underground cave. It is technically a "karst window" (one of only four in Florida) and has been known to reverse flow direction.

Fannin Springs is a popular recreation area (swimming, snorkeling, picnicking) and is considered by many to be one of the prettiest first-magnitude springs. It is also a manatee refuge.

[Many thanks to Bill Wilson for sending in the clipping.] ■

DROWNING AT SAC ACTUN

by Steve Gerrard (NSS #26640)

On Oct. 17, 1990 a 38-year-old cave diver from Normal, Illinois, certified full cave in the spring of 1989 and with 53 logged cave dives, drowned in the Sac Actun cenote/cave system located 6km north of Tulum, Mexico on the road toward Coba. This accident occurred on the fifth day of a six-diving-days group trip.

The group of eight (all had full-cave certification), with one sherpa, arrived at the parking area at approximately 10:30 a.m. Everyone walked the rugged path down to the water to become familiar with the trail and where to enter the water. Back at the vehicles a detailed sketch had been made on paper of the cave system and a dive plan was thoroughly discussed. The plan was for the group to be divided into two teams to make a traverse from Sac Actun to the "Grand Cenote," which would take about 22 minutes at a maximum depth of 40′. It was explained that the traverse dive would involve a 70′ gap approximately 280′ upstream from Sac Actun to the permanent line going downstream to the Grand Cenote, and that there was a pink directional line marker on the Sac Actun line at the location of the gap.

The plan was for the lead divers to install the gap reel. On the second dive (the return trip from Grand Cenote to Sac Actun) the second team was to pick up the gap reel. Once back at Sac Actun, after recalculating thirds, the group would go in the opposite direction and swim another "upstream" passage that would involve a third cenote, a visit to a beautiful room of speleothems, and a loop. Everyone acknowledged that they understood and agreed to the plan.

Once in the water, everyone paired up in the teams and performed their bubble checks, and matching and safety drills. The dive plan was reviewed and a sketch which had been drawn on a slate was shown to everyone. An agreed-upon order was established and the first dive began.

Arriving at the pink arrow marker, members of the first team attached a gap reel and began swimming in a 90-degree turn to the right, installing the gap line, with everyone following closely behind. At the permanent guideline, the gap line was attached and everyone proceeded downstream toward the Grand Cenote, enjoying the large white passageway.

At the Grand Cenote another gap reel was attached to the permanent guideline to lead out into the huge cavern zone in order to make it easier to find the permanent guideline on the return swim. All of this area is within natural daylight. At the surface, everyone was impressed with the beauty. The dive took 24 minutes with a maximum depth of 39', with everyone having between 2300-2400psi in their double 80cf tanks. One diver had 2600psi. All had started the dive with 3000psi.

During the 15 minutes of surface interval, the second dive plan was reviewed twice and the sketch on the slate was shown for the second time. One member of the second team asked a question and the dive plan was reviewed for a third time. The fact that everyone had breathed between 500-700psi on the way over and would probably use at least 500psi on the way back to Sac Actun was discussed. Everyone agreed that they understood the dive plan and that members of the second team would pick up the reels.

At the beginning of the dive, all of the divers swam over to one side of the cavern zone to observe a crocodile skeleton. There was one delay as one member of the first team dropped his mask and a member of the second team retrieved it. The first team gathered and began the return swim back to Sac Actun, with the second team following approximately 100' behind, picking up the reel in the Grand Cenote cavern zone.

The first team arrived at the gap reel, with the team leader detaching the gap reel and signaling the other three to swim ahead and follow the gap line to the pink arrow marker. This diver waited for the second team to arrive, which was moments later. Three members of the second team began the swim across, and the first team leader handed the gap reel to the fourth diver of the second team and motioned for him to go ahead and reel up the gap line while he (the first team leader) caught up with his own team members, who had now arrived at the pink arrow marking pointing to Sac Actun.

Turning left, members of the first team began swimming toward Sac Actun, with the team leader now back in the lead. The team leader of the first team looked over his shoulder and saw one member of the second team following the first team and saw the other members of the second team arriving at the pink arrow marker.

The first team arrived back at Sac Actun and noticed that there were no lights from the second team behind them. The team leader figured that the second team must have been delayed, perhaps with a jammed reel at the 70' gap. As planned, the first team recalculated thirds and proceeded on a new line in the opposite direction, which involved a "snap-and-gap" of 3'. Hooking up the snap-and-gap to maintain a continuous guideline to the surface at Sac Actun, the first team began swimming slowly upstream. At 200', the team leader began to feel uncomfortable because the second team still had not caught up.

He immediately took members of the first team another 75' ahead and surfaced at the third cenote. He asked everyone when they had last seen the second team. All agreed that it was at the area of the pink arrow marker. The team leader asked the other members of the first team to stay at the surface of the third cenote while he went back looking for the second team, wondering what had happened to them.

Back at Sac Actun, no sign of the second team. He immediately proceeded on to where the pink arrow marker was. To his shock he found that the gap reel had been put back in place. His only conclusion was that the second team had gotten confused and had done the "smart" thing and swum back to the Grand Cenote. Swimming all the way to the Grand Cenote, the first team leader found no sign of the second team, so he swam back to the 70' gap line and the pink arrow marker.

He concluded that the second team had turned right (instead of left) and gone further into the cave system . . . or . . . somehow they had missed each other while the first team was on the surface of the third cenote, which he doubted. At this point nearly 30 minutes had elapsed and the first team leader was down to 1500psi; he figured that there was no point in going upstream and that the second team would realize their mistake and call the dive.

Returning to the third cenote, the team leader called the dive and the first team returned to Sac Actun. At the surface, the team leader decided to go back down for one more look. As he dropped down and started heading toward the pink arrow marker, he immediately saw three lights of the second team swimming down the passage toward Sac Actun. What relief—but where was the fourth light?

As the first team leader approached the first two lights he saw that they were sharing air. One of the divers immediately expressed through hand signals that there was big trouble behind them. Swimming further, the first team leader discovered a set of legs dangling limp from a tiny air pocket on the ceiling. Swimming up to the torso area of this diver, he tried to pull him down in an effort to stick a regulator in his mouth, but the diver was too buoyant and would not budge.

At the same time, the first team leader began purging his regulator in order to fill up the small air pocket, remembering the Otter Springs rescue in Florida, where Woody Jasper saved two lives by doing this. Jamming his hand up into the air pocket, the first team leader felt the diver's face and found it was still warm, and then felt the diver begin to gulp for air. He was still alive!

Feeling for the diver's mouth, the first team leader found it and placed his long-hose-regulator second stage into it, and the diver responded by grabbing it. After a minute or so of gaining composure and trying the breathe normally again, the diver dropped down from the air pocket. His mask was wedged in his left hand. The first team leader pried the mask from this hand and placed it into his right hand. The diver put the mask on and cleared it. The first team leader firmly took the right hand of the diver and escorted him the 150' to the surface.

Once at the surface, all members of both teams yelled that there was still one diver missing back down in the same area. The two divers who had been sharing air were gasping for breath, as they had just made it to the surface on the last breath from the one diver's double 80cf thanks. The first team leader looked at his air gauge and determined that he had better take another diver with him, and asked a member of the first team to follow him.

Swimming back down to the same area where the first rescue took place, they found the missing diver another 20′ beyond on the floor, face up with his mask on and regulator out of his mouth. Both divers immediately pushed one of their regulators into the diver's mouth and purged air, but there was no response. Each diver grabbing an arm, they pulled the diver as fast as they could the 170′ back to the surface.

At the surface everyone began peeling off equipment and pulling him to shore to begin immediate mouth-to-mouth resuscitation. After five minutes of futile attempts from two individuals, everyone agreed to stop and accept the fact that the diver was dead, and all sat there in shock.

WHAT HAPPENED? The three surviving members of the second team recollected the following information. When the last member began reeling up the gap line and had gone about a third of the distance back to the Sac Actun line, another member of the team swam over and stopped him (this turned out to be the deceased). He signaled to put the reel back in place, which was done. The deceased and first member of the team then swam to the area of the pink arrow marker and turned right, going upstream further into the cave system. The third team member, who had begun to follow the first team back to Sac Actun, saw this and psychologically figured that he was wrong and they were correct, and therefore followed the first two. The fourth team member also followed.

Apparently no one, at this point, was aware that they were going in the wrong direction, thinking that they would meet up with the first team as planned. Though the distance is difficult to calculate, judging by the amount of elapsed time, the team must have swum 1000′+ upstream. At one point, the deceased stopped to check his air supply and continued on. Finally, the first member stopped and wrote on his slate, asking the other divers why they hadn't seen the other team yet.

At this point everyone was beginning to feel doubt. The team called the dive, and everyone reversed the order to the exit. Three of the divers had about 1000psi or less at this point, and the fourth diver had approximately 1500psi.

On the way out, the team found a snap-and-gap to the right and took it, thinking that this might be the way to the third cenote. They swam about 100′ and saw an arrow marker pointing in the direction they had come from and turned around and returned to the main guideline.

Swimming out, the third diver's fin strap popped off its post, causing a delay. (The fins were properly taped but were of the new adjustment design.) Other team members helped with the fin. At this point, no one had seen an arrow marker for quite awhile! Because of growing stress, from not knowing how far they were from surface air and the fact that their air supplies were dwindling, the first diver and the deceased started swimming faster and harder, passing the third and fourth divers, stirring up silt and disappearing out of sight.

Finally, about 600′ from Sac Actun, the third diver ran out of air and began sharing air with the fourth diver. They were very stressed but concentrated on following the guideline and did not lose control. The fin strap popped off for the second time and they abandoned the fin, making swimming more difficult. At the same time the first diver and the deceased were swimming as hard as they could.

ACCIDENT ANALYSIS.

Training: Everyone was full-cave trained. Two of the divers of the second team had upgraded to full-caver certification earlier in the week and had logged about 25 cave dives each in Florida and Mexico. The deceased had logged 53 cave dives, according to his log book. And the other diver had logged approximately 120 cave dives.

Guideline: A continuous guideline from the surface was maintained throughout the dive, though the team, on the way out, took a short visual gap but returned to the main line. Confusion and unfamiliarity with the cave system doubtless played a strong part with this accident scenario.

Air: Obviously, this was a major factor in the accident. It is assumed that the deceased, and known that two of the other members, did not use proper air management and were into their Critical Air Supply, not realizing that they did not know how far they were from surface air.

Depth: Not a factor in the accident as maximum depth reached was 40′.

Lights: Not a factor in the accident as everyone maintained a minimum of three lights and no light failures occurred.

CONCLUSION. Inexperience, poor judgment, and mismanagement of air supply were probably the contributing factors for this accident. Though the dive plan was diagramed on paper and on slate, and reviewed a total of five times, the complexity of the dive plan—involving a loop, the third cenote, and a gap in the opposite direction of Sac Actun—caused confusion. After the fact, two of the surviving divers stated that they understood the dive plan but were lulled into the "following the leader" syndrome.

This accident, though tragic, was nearly catastrophic in that the other three members of the second team nearly drowned themselves. Only through a calm, orderly exit by two of the team and the heroic efforts of the leader of the first team, who saved the third diver, was this accident held to a single fatality rather than a quadruple drowning.

The following week, the local cave-diving community replaced the guideline between Sac Actun and the Grand Cenote with a continuous ¼" guideline, and the upstream passage from the pink arrow marker now requires at least an 80′ jump line. And...one must now use a primary reel from the surface to the permanent guidelines going in either direction from Sac Actun.

About the Author: Steve Gerrard has served the cave-diving community for many years as President of the NACD (National Association for Cave Diving) and as the coordinator of numerous NACD cave-diving workshops. He is currently NACD Vice President; Editor of its bimonthly newsletter, *The NACD Journal;* and chief architect of the NACD's forthcoming book, *The Art of Safe Cave Diving.* He is one of our most prolific cave-diving instructors and has trained hundreds of cavern and cave divers through both the NACD, NSS-CDS, and NAUI. He is presently a full-time cave-diving instructor in Florida and conductor of guided cave-diving trips for certified divers in Mexico, and was the "first team leader" in the above accident report. ■

LETTERS

Conservation and Safety?

[Letter to the Editor]

October 31, 1990

While contemplating the past accident in Sistema Sac Actun (Quintana Roo, Mexico), I find my thoughts drifting to the original designs of the cave. Obviously, I am saddened by this drowning. He and his mates were all trained cave divers; each of them had their own brush with death to one degree or another. The incident, as I understand it, came to within a hair of claiming the entire team of four. Exactly how and where the incident occurred in the cave, though, disturbs me to no end.

Sac was discovered in October, 1987. During the exploration period, a verbal agreement was reached between all of the individuals who knew of the cave. The basic foundation of the pact was quite simple. Sac was not to be used as a training cave for students, nor a practice ground for trained divers who were improving their caving skills. Sac was, and still is, considered to be an open cave for proficient cave divers. This understanding had no purposes of elitism; it was made with honorable intentions for the benefit of all cave divers.

Some months later, words of honor lost out to the demands of the curious. This was a regretable, but understandable, progression of events. So Sac Actun was relined in late 1988, when three distinct guideline regions were created in the cave.

Sac had at that time 9 separate cenotes associated with the upstream cave system. It needed an "easiest-to-air" permanent-line configuration that was not confusing, and also protective of the fragile nature of the cave. In order to accommodate the popular demand for a 900′ traverse to the Grand Cenoote, a well-marked 80′ gap was established between two guideline regions so that the inquisitive had a known reference point in the cave.

In physically making that gap, the diver knew that directional line markers would change, pointing to nearest air. It all depended on which side of the gap reel you were on. The traverse depended upon the reel. Cave divers depend on line references. It seemed so simple and ideal. Apparently someone was not paying attention, even if the dive plan called for more touring.

Since this last incident, the guidelines have been reconfigured again. The traverse is now lined with a continuous heavy-duty nylon guideline. Divers must also run a reel to the start of that permanent line. All snap-and-gaps have been removed from the cave, and any offshoot lines from the traverse line are gapped at quite a distance. Further line reconfigurations in the further reaches of Sac are being considered. By these actions, I am not sure if Sac Actun has changed character.

No plans have been made at this time for hiring cave police or cave-trained attack dogs to patrol the premises. Sac is still on the honor system and open to all cave divers at the present time, I think.

The landowner was not present during the time of the accident. He and his family were spared the gory details, fortunately. I intend to visit this very friendly man when he returns from his vacation. He does need an explanation as to what happened on his property while he was away. I will be very sad should we all lose even more.

Jim Coke (NSS #26442)
Playa Del Carmen, Quintana Roo, Mexico

* * *

Knotted Line

[Letter to the Editor]

November 26, 1990

This is in response to Roger Werner's article, "Knotted Line" [*UWS* Vol. 17, No. 5, Sept./Oct.]. I have used Roger's marked arrows as references on many occasions, especially at Manatee. I appreciate someone who has taken the time to measure, mark and place these references for others' use. Since I did this placement at Little River, I know how time consuming that kind of project can be, and how many variables need to be considered.

We cannot, however, have everyone doing his own thing for his own logical reasons. When marking the way out, that way should be pointing to the most direct way out on a *continuous* guideline. If you pointed out to a shorter way that required a jump or knowledge of a system, this could prove to be confusing and hazardous. It could cause someone to doubt the way out if he was not very familiar with the system, or could cause a basic cave diver to make a jump if he believed he was exiting and doing the right thing. There must be consistency in order to make this a safe system. We should standardize and publicize the procedures. (See *UWS*, Vol. 17, No. 3.)

In the Devil's Eye system, are the arrows marked from the beginning of where the permanent line used to be (about 300′ in) or the beginning of the current permanent line? It seems like the first arrow says 500′, when it is really about an 800′ penetration. It may be good to use a benchmark that is not likely to change, such as the exit point to open water.

Sincerely,
Wendy Short (NSS #30802)
Jacksonville, Florida

* * *

Diving Deep on Nitrox?

[Letter to the Editor]

November 23, 1990

Harry Averill, Editor of *Underwater Speleology* at the time and listed as Training Coordinator in Vol. 17, No. 5, and Joe Prosser, Training Chairman of the NSS-CDS, wrote an editorial titled, "Prove Just How Macho You Really Are . . . Di(v)e Deep on Air," in *Underwater Speleology*, Vol. 17, No. 4. They made many good and valid points on the dangers of diving deep on air due to the incapacitation caused by nitrogen narcosis, but some of their statements regarding mixed-gas diving are false and some of the inferences they make about nitrox diving are sufficient to cause great concern. The average cave diver reading this editorial will arrive at completely wrong conclusions about nitrox diving and will be encouraged to use nitrox in a very dangerous manner.

Nitrogen Narcosis: Nitrogen narcosis is due to impairment of the entire central nervous system (brain and spinal cord). This impairment is caused by nitrogen having a sedative or slowing effect on the brain that is similar to but not identical with that caused by alcohol. The first areas of the brain to be affected are the inhibitory pathways, the ones that keep us under control, and that is why a few drinks or a little nitrogen make the average individual feel more active, spontaneous and outgoing. As the level of alcohol or nitrogen increases, the sedative effect involves all areas of the brain and spinal cord and the individual starts to notice his impairment and eventually loses consciousness. Somewhere in the middle of this process, judgment becomes severely impaired.

Nitrogen narcosis is directly related to the partial pressure of nitrogen. The partial pressure is a function of the percentage of nitrogen in the breathing gas and the total pressure of that gas (the depth in diving). Therefore, the sedation due to nitrogen narcosis starts as soon as the diver goes underwater and increases with increasing depth. Most experienced divers do not notice the effect at depths of less then 100′ because the effect is relatively small and they do not know what to look for. Experienced divers notice the effect as shallow as 30′. At a depth of 130′, average divers suffer enough incapacitation to effect their judgment and therefore most certifying agencies, including the NSS-CDS, limit air diving to 130′.

Nitrogen narcosis affects all divers equally. However, the ability of a diver to cope with and function while under the effect of nitrogen varies dramatically from diver to diver, and in the same diver from day to day. If you are tired, stressed, under the influence of any sedative drugs, including most antihistamines and alcohol, or physically ill, the effect of nitrogen narcosis on your judgment and ability to function will be much more severe.

The prime determinant of your ability to function while impaired is the degree that the task you are trying to do is within your experience, training, knowledge, skills and abilities. Very well-trained open-water divers with experience coping with nitrogen (military, commercial and very senior recreational divers) can safely dive to depths of 150′ and occasionally 180′ under ideal conditions. Cave diving by its very nature is much more complex and a limit of 130′ is reasonable for all cave divers. It is vital to remember that "certification" is not the same as experience, training, knowledge, skills and abilities.

Nitrox Diving: Nitrox diving, or enriched air diving, refers to the practice of diving with a gas that has more than 21% oxygen. The main advantage of nitrox diving is that it reduces the amount of nitrogen taken up by the body during the dive (the percentage of nitrogen in the breathing gas is less than 80%). Therefore, the required decompression is reduced. As a useful side effect the reduced partial pressure of nitrogen also means that the diver will suffer less nitrogen narcosis.

The main problem with nitrox diving is oxygen toxicity, something Averill and Prosser seem to have missed completely. As you increase the percentage of oxygen in the gas, you increase the partial pressure of oxygen you expose your body to during the dive. Current diving medical research has shown that an oxygen partial pressure of 2 ATA is the maximum safe level for a resting diver and therefore the maximum depth at which 100% oxygen is used during decompression in the Defence and Civil Institute of Environmental Medicine (DCIEM) air tables is 9m (30′). For a working diver, the Canadian Forces uses a partial-pressure-of-oxygen limit of 1.6 ATA. Other militaries use a limit of 1.4 ATA and several diving medical authorities consider a limit of 1.3 ATA appropriate.

If we use a limit of 1.6 ATA, the maximum safe diving depth on air because of the risk of oxygen toxicity is 218′ (1.6 ATA ÷ 0.21 ATA = 7.6 ATA total pressure, 6.6 ATA x 33fs ÷ ATA = 218′). The danger of oxygen toxicity is that the first sign of problems is often a convulsion with loss of consciousness. The convulsion will not do you any harm, but if it happens while you are underwater you have an excellent chance of drowning. The susceptibility to oxygen toxicity does vary from person to person, but the variation from day to day in the same individual is very large. Therefore, the fact that you did not convulse when exposed to a high partial pressure of oxygen today is no guarantee that you will not convulse the next time you are exposed.

Averill and Prosser state, "while the operational limit of Nitrox I—130 feet—is the same as that of air, for those with a serious, legitimate interest in some day going deeper, Nitrox offers these benefits: . . . " They then go on to list some of the valid uses of nitrox. However, *they have clearly implied that nitrox is safe to use deeper than 130′*.

The maximum safe depth for a 32%-oxygen, 68%-nitrogen mixture, based on oxygen-toxicity considerations, is 132′ (1.6 ATA ÷ 0.32 ATA = 5.0 ATA total pressure, 4 ATA x 33fsw ÷ ATA = 132′)! To dive deeper than 132′, the percentage of oxygen in the mixture will have to be reduced, but as the percentage of oxygen is reduced the percentage of nitrogen is increased such that there is little if any reduction in the level of narcosis compared to diving on air. Clearly, nitrox is useful for reducing the required decompression and for reducing the amount of nitrogen narcosis if a high enough percentage of oxygen is used, but it is NOT very useful for diving deeper than is safe on air because of the danger of oxygen toxicity.

Heliox and Tri-mix Diving: Later in the same article, Averill and Prosser state, "Breathing most combinations of heliox or tri-mix can prove fatal at shallow, decompression-stop depths." Is this really true? Heliox refers to a gas mixture of helium and oxygen. Helium is used because it is far less narcotic than nitrogen and dives have been done to several hundred feet on helium with almost no narcotic effect. Tri-mix refers to any gas mixture containing oxygen and two other gases, usually helium and nitrogen.

Tri-mix was originally developed to counteract High Pressure Nervous Syndrome (HPNS or Helium Tremors) on very deep helium dives (for several hundred to over 2000′). More recently, tri-mix has become popular for dives in the 130-250′ range because helium is very expensive. Tri-mix allows just enough nitrogen to be replaced with helium to keep nitrogen narcosis under control (equal to a 130′ dive on air, for example) and to keep the cost of the gas reasonable. Why then would it be fatal to breathe this gas at shallow, decompression-stop depths?

For dives deeper than about 220', the amount of oxygen in the gas is reduced to prevent oxygen toxicity. If the gas has less than 16% oxygen, and the diver is on the surface, and if he then tries to work to maximum, he may pass out due to a a lack of sufficient oxygen. However, if he sits quietly he can remain conscious (although severely impaired) with less than 10% oxygen in the breathing gas. Therefore, combinations of heliox or tri-mix designed for use at depths of several hundred feet will contain such a low percentage of oxygen that they could result in loss of consciousness and drowning if breathed at shallow, decompression-stop depths, but the vast majority of mixes would be completely safe.

Finally, Averill and Prosser state, "While several computer models are available to construct theoretical dive tables for a variety of heliox and tri-mix combinations, none of these tables have undergone the large-scale empirical testing that compressed-air and Nitrox tables have undergone." This is only partly true. Compressed-air dive tables all have some degree of testing and the current DCIEM tables are, in my opinion, the most rigorously tested tables in existence (they are still far from perfect). Most nitrox tables are based on calculations of equivalent air depths and therefore are really air tables in a different format. Thus, as long as the mathematics were done correctly, they should be as reliable as the air tables that were used in their calculation. In fact, because more than 21% oxygen is breathed during decompression, nitrox tables should be slightly safer than the air tables they were derived from.

The US Navy developed and has used a set a Helium Partial Pressure Tables for many years, but there are acknowledged problems with these tables. The US and Royal Navies are involved in a joint project with the Canadian Forces to develop new Heliox Tables. DCIEM is the lead institute in this project and testing of the tables is almost completed. Tri-mix tables are calculated from extrapolations of nitrox and heliox tables and the authors are correct in their statement that these tables have not undergone large-scale empirical testing.

In conclusion to this somewhat lengthy letter, I was very concerned with some of the comments made by Averill and Prosser in regards to nitrox and tri-mix/heliox diving. My concern became even greater when I read, "a small number of NSS-CDS Instructors will begin offering training in mixed-gas theory for those with a serious, legitimate need to exceed a depth of 130 feet." I trust the Instructors will have a much better understanding of Nitrogen Narcosis, Oxygen Toxicity, and Mixed Gas Theory than that reflected in this editorial by the Training Chairman and Training Coordinator of the NSS-CDS.

Major David Sawatzky, M.D.
(NSS #30362)
Head, Diving Medicine
DCIEM (Defence and Civil Institute of Environmental Medicine)
Toronto, Canada

* * *

Computer Mapping

[Letter to Joe Prosser, Training Chairman]

February 10, 1990

Greetings, Joe . . . . . .

A note to let you know what your help in finding mapping software has accomplished.

In my last, I mentioned that I wanted to be able to accept data and return maps. That I can do, most willingly. I would be glad to pass anyone's data into a program and return maps to them.

I'm using Doug Dotson's SMAPS V4.2 on IBM, Steve Peerman's Cave Mapping System V6.6 on an Apple IIe, and Gary Petrie's KARST8 on IBM. I haven't been able to locate what I want for the Macintosh. I'm doing some "same data" comparisons on all of these programs and hope someday to know which is the best for me. All of them have good points. I'm anxious to see Dotson's latest version, which has his finished graphics package. Gary and Steve may also have new versions that I haven't seen. I started using Doug's SMAPS in May '89, Gary's KARST8 in June '89, and Steve's CMS in August '89. If updates are available, I'd like to try them.

The point of "The Great Software Hunt" last year was to provide help for Jim Coke, Tom Young, and Mike Madden with their mapping of the cenotes of the Yucatan. That has happened. Presently, they are using SMAPS. Mike has entered an enormous amount of data from Cenote Nahoch Nah Chich (more than 35,000'). See the Nov./Dec. '89 issues of both *NACD Journal* and *Underwater Speleology* for more info.

Jim and Tom have finished and published their magnificent map of Cenote Naharon. Those of you who attended the NSS-CDS Winter Workshop can attest to the effort that went into all phases of this work. I hope that other maps are on the way from this team. They used SMAPS to correlate and check data. Error ratios on the loop closure for that survey were very, very small; almost nil. That's accurate survey work!

Data has been (and is being) accumulated from several cenotes— Naharon, Sac, Carwash, El Garceno, Temple, Dos Ojos, Maya Blue and Tancah. Several others are active in the Yucatan. Hilario Hiller and Tony and Nancy Del Rosa are exploring and surveying Balankanche and other cenotes, and Karst Environmental Services is working to the north around the Mayalum area. I hope to be able to include data from both of these exploration teams in order to complete a large-scale map of the area.

A number of land surveys have been completed and connection mapping efforts are underway. We're beginning to have an overview of the entire area. The surveyors in the Yucatan have been very cooperative about sharing data and I am certain that it will continue.

Computer use in the cave-mapping world is growing quickly. If you read *Compass and Tape* you will have noticed more and more being reported concerning computer use. I was surprised to not find someone on the NACD Bulletin Board System talking about maps. Don't any of you guys have modems?

Can anyone recommend a source of cave-diving videos? I am working with various local clubs and organizations and would like to promote some cave awareness. Check out the Jan./Feb. '90 *International Wildlife* for a nicely done article with good photos of several Yucatecan cenotes.

Again, many thanks to all of you for your help.

Safe Caving!
Dr. Harve Thorn (NSS #29599)
Mexico City, Mexico

* * *

NSS Membership

[Letter to the NSS, with copy to CDS; published in NSS News, *Vol. 48, No. 11, Nov. 1990]*

September 16, 1990

As a member of the NSS for several years, since 1980, I would like to express an opinion. I have been a member of the NSS solely to be involved with the CDS. Because I am not interested in dry caving, I get, in my opinion, very little from NSS membership. Although I do agree with NSS philosophy and agree with protecting dry caves and landowners' rights, I am not involved nor interested in dry caving. My interests lie in underwater cave exploration.

The NSS newsletter very rarely has any articles on cave diving, nor does its "Coming Events" list any CDS events, and since cave divers *must* be members of the NSS in order to join the CDS, the NSS should show more involvement toward the CDS and cave diving, or offer a CDS membership only.

I would like to continue my membership with the CDS but feel I gain very little benefit from paying NSS dues.

I believe there are other cave divers who feel this way and I would appreciate your printing this letter so others, too, can express their opinions.

Sincerely,
Danny Mackey (NSS #29744)
Canton, GA

Guest Editorial: THE BENEFITS OF NSS MEMBERSHIP

G. Wayne Marshall (NSS #20373)

I read with some regret the letter from Danny Mackey regarding his dissatisfaction as a Cave Diving Section (CDS) member of the NSS. Education is always the first line of defense against prejudice. I will therefore attempt to address a large subject area in a short article by specifically discussing each significant point made by Mr. Mackey. I will also attempt to perhaps clear up some of the misconceptions of the non-diving members of the NSS.

With apologies in advance to Danny Mackey, I am going to address a broad spectrum of topics and concepts which are implied or inferred in his short, but potently negative letters to the editors of both the *NSS News* and *Underwater Speleology*. His letter contains the sort of overt backbiting that is almost always the result of a narrow perspective which needs development, maturity and broadening. Many people have been working for many years to encourage an open-arms relationship between the Cave Diving Section members and the mainstream NSS membership. Tremendous progress has been made on many fronts. I believe Mr. Mackey typifies the type of myopia that has allowed cave divers in general to be misunderstood and under-appreciated by the majority of the NSS membership.

As I read his letter, my first reaction was one of profound sadness. I thought to myself, "Here's another one that doesn't see the big picture. Here is yet another person who wants to focus a narrow beam of interest and foster an environment of limited understanding. He just doesn't recognize that he can belong and contribute to a concept or an organization that is much larger than his specific interests." It wasn't too long ago that the cave-diving community at large had the very same philosophy. Thanks to the enlightened leadership of the NSS and the CDS, the times are changing.

First, Danny confirms that he has come into the NSS and caving in general due to a specific interest in cave diving. There are two traditional paths into the membership of the Cave Diving Section. The first path is through traditional open-water scuba-diving training and exposure. The majority of the CDS membership consists of divers who have gone directly from open-water diving into cave diving, thereby skipping any form of dry caving activity. They have discovered that there are tremendous differences between open-water diving and cavern or cave diving. The uniqueness of the cave/cavern-diving experience is much too involved to be discussed in this article.

There is no other ecosystem in the world of fresh- or saltwater diving which parallels cave diving. The subject of penetration diving into wrecks is similar in that both divers are in a restricted overhead environment. Most comparisons between the two stop at that point. The challenges of cave diving, both psychological and technical, are also much different that those dealt with by typical open-water divers. Many divers find the concept of moving through living geology fascinating. Certainly, the same could be said for many dry cavers.

In Florida and the southeast, many cave divers have been open-water scuba divers that have grown into cave diving as a skill-level progression, or as an alternative to open-water diving in the winter months. Dive shops from all over the eastern half of the United States bring their scuba-diving classes to the clear, relatively warm waters of Florida's springs. In many cases, this is the students' exposure to scuba diving outside of a swimming pool. Some of these divers develop an immediate desire to continue on in their training to the additional levels of Cavern Diver, Intro Cave Diver, Apprentice Cave Diver and Full Cave Diver, as taught by the Cave Diving Section's exemplary training programs. Some divers decide that they do not enjoy the cavern-diving environment and go on to other destinations within the diver's realm.

Unfortunately, some divers attempt to cave dive without proper equipment and training. These divers usually survive the experience, but a small percentage become fatalities due to errors in judgment, procedure, or technique. Hence the need for outreach to people such as Mr. Mackey, who has apparently received such proper training through an NSS-certified Cave Diving Instructor. Certainly the Cave Diving Section has created an excellent model for grottos and other sections to follow on how to outreach to a specific population of participants.

The second path to membership in the CDS is that of an experienced caver that has developed over time a need to explore additional cave passage that is terminated by a sump. Often this person's desire to cave dive is very site specific. Unfortunately, such sites are always a substantial number of work/effort units from the entrance of the cave. That translates to requiring many, many helpers (affectionately called Sherpas) to assist in a major coordinated effort to transport one or two sump divers to an in-cave dive site. It is not unusual to have as many as 25-30 sherpas working over several trips to fully support one or two cave divers for a single exploratory dive.

The objective of this group is to find additional air-filled cave beyond the sump to continue the exploration effort of a particular cave system. In contrast, the typical Florida cave dive may allow for a vehicle to be parked within a few feet of the dive site and the objective is often a purely recreational one for a small group of two or three divers. It is extremely rare for a Florida cave dive to reach any air-filled space. The entire cave system is filled with water. There is usually no exploration objective as most cave systems have been fully explored and surveyed or mapped. The sump diver uses cave diving as a means of transportation to assist in the task of exploration. The Florida cave diver uses the dive as the desired end.

This becomes a critical difference. Florida cave diving can be practiced independently, in somewhat of a vacuum from the rest of the caving world. Sump diving is therefore much more social in that many people are involved and share in the project responsibilities and objectives. Thus, the methods frequently employed by Florida-style cave divers tend to isolate them from the mainstream.

Mr. Mackey says that he is not interested at all in dry caving. I would submit that his exposure to cave diving is somewhat limited in scope if he is not involved in sump diving as a sherpa and then on into sump diving. Further, there is the completely different activity of mine-shaft diving. Dr. Bill Stone, of both the Huautla Project and the Wakulla Springs Project fame, once told me that he had become convinced that the needs of the Huautla Project would be better served by taking an existing cave diver and converting him into a vertical caver than vice versa. Apparently, after much investigation on his part, he realized the unique skills of the competent cave diver were not as easily duplicated as the unique skills of a competent vertical caver. So, Danny, there is some basis for hoping that you will get an opportunity to be called to participate in some major international cave-diving expedition. If you are interested in this type of cave-diving opportunity, I would suggest you find a grotto to join and participate fully in their caver training program, ASAP.

Mr. Mackey implies that he does not benefit from his NSS membership, maintained since 1980, apparently at great personal sacrifice. I submit that such is far from the case. First, let's set the record straight. Upon my query, the NSS office tells me that, to the best of their knowledge, he did not become a member of the NSS until September, 1988. Secondly, as of this writing (November, 1990), Mr. Mackey is no longer a current member of the NSS. In his defense, however, it is quite common for CDS members to renew their membership at the annual CDS Winter Technology Seminar held the last weekend in December. Perhaps Danny will be a current member by the time this article is published.

When cave divers needed relevant examples and references as to how and why landowners should feel comfortable in allowing continued access to their cave-diving sites, the NSS delivered. Other NSS cavers have provided an excellent model for cave divers to follow in the area of landowner relations. There is a history of many decades of good relations between dry cavers and landowners. Further, it was the NSS which provided enough clout, largely due to previous working agreements, to enable the Nature Conservancy to see the wisdom of purchasing the Peacock Springs area in order to preserve perhaps the premier cave-diving site in the world.

As to the matter of the *NSS News* not carrying sufficient information about the Cave Diving Section's activities or upcoming events. I unequivocally state that during my stint of about 4 years as editor of *Underwater Speleology* every single piece of material submitted to the *NSS News* was published. All of it! I believe that succeeding editors would say the same thing. I have also found that the *NSS News* editors will publish any events in their "Coming Events Calendar" for which they receive adequate lead time. Granted, the lead time is approximately 90 days, but that should not present a problem for CDS activities. I believe the Cave Diving Section should be faulted for not updating this coming events calendar, rather than the *NSS News*. It is clearly the leadership of the Cave Diving Section that is responsible for this matter.

Responsibility for the lack of articles of interest to you in *NSS News* is also thrust back to the CDS membership. Alas, they don't submit enough to their own publication; how can we expect them to submit to *NSS News* in addition? The burden of responsibility is not upon the editors, but rather the authors. How many times have we all said to ourselves, "I should write this up!" . . . AND THEN DIDN'T FOLLOW THROUGH? Frankly, Danny, your letter to the *NSS News* elicited just such an "I should write this up!" response in me. I am indebted to you for that, as this topic needed discussion a long time ago.

Why should the NSS general interest publication be the preferred document to publish articles of a highly specialized nature? The structure of the

NSS publications allows at least seven different levels of specialization or generalization in its publications. These are the *NSS News*, the *NSS Bulletin*, section newsletters such as *Underwater Speleology* or *Nylon Highway*, grotto newsletters, NSS informational and educational brochures, NSS and CDS published books, and annual *Speleo-Digest* issues, which are often a compendium of all the others. Furthermore, most authors submit to be published in *Underwater Speleology* by preference.

With all that specialization, there is still a need for general-interest articles on Cave Diving in the *NSS News*. I found it ironic that Mr. Mackey's letter was published in the same issue as an excellent general-interest cave-diving article by Wendy Short. An additional irony is that I had the pleasure of meeting Wendy and her husband through the monthly dry-caving-oriented grotto to which we both belong (Tampa Bay Area Grotto) rather than through the semiannual CDS-sponsored events. One of life's little serendipities has been the discovery that my wife and son can share in my dry-caving adventures; they are always excluded from my cave-diving activities.

I can only speak from personal experience, of course, but I have put a little effort into defining my place in the NSS as an organization. That effort has extended to dry-caving activities as well. That small investment in personal commitment has been returned many times over. I have had the pleasure of having the NSS President, John Scheltens, and his equally interesting wife, Pat, as guests in my home. I have had the opportunity to explore dry caves in other states including Lave Tube and Ice caves in the Pacific Northwest. I have attended NSS Conventions and met and laughed with cavers and cave divers from all over the world. I now feel that I have friends that can assist me in my continuing efforts to cave dive in many parts of the world. It has been my distinct pleasure to meet and know as friends some of the finest individuals, from all walks of life, that one person could be blessed with. I can only aspire to be as good a friend as these all have been to me.

I have been able to participate in expeditions, domestic and international, both as a participant and as an observer. I have seen the CDS participate in and sponsor the foremost Cave Diving project in history, the Wakulla Springs Project. Joining the Cave Diving Section as sponsors were such organizations as the Explorers Club, the National Geographic Society, Nikon, Rolex, Dive Manufacturing, Viking Drysuits and Body Glove, Cis-Lunar Engineering, Inc., the Department of Natural Resources of the State of Florida, . . . the list goes on and on. It was the professionalism and prestige of certain members of the scientific caving community that created the concept and the reality of this project.

I have also been able to know personally some of the foremost leaders and developers of new cave-diving technology and to benefit from their expertise. Many of them gravitated to the CDS because of their initial interest in dry caving. It has been my pleasure to serve on the CDS Board of Directors for several years, as well as being selected as Chairman of the Tampa Bay Area Grotto. It has been my honor to have been asked to run for the Board of Directors of the NSS. Unfortunately, I have not yet been chosen by the NSS voting members for that particular opportunity to serve. I haven't given up on that goal, however.

I steadfastly believe that the way to mainstream the CDS within the NSS is by positive, productive interaction on equal terms with the NSS membership rather than the accusing method implied by Mr. Mackey. Danny, I mention these items only to illustrate one person's level of growth as a CDS member turned NSS advocate. I, too, once felt as you do. I decided some years ago to work from within the NSS structure to try and accomplish some of my personal goals. I submit to you that you are the one who is rejecting the NSS; they are certainly not rejecting you!

I believe the CDS needs to have representation on the NSS Board in order to help others to understand how we can work together to facilitate further caving knowledge and activity. We are surely not limited to furthering knowledge within the cave-diving community. We, as an organization, must continue to address the fact that more divers have died while cave diving than by shark attack. The open-water scuba instructional agencies have steadfastly resisted the efforts of many cave-diving individuals and organizations over the years to help educate their instructors and student divers to the hazards of cave diving without proper training. I believe the doors are soon to come tumbling down. The CDS has the resources in talent, finances, and technological resources to make a difference in saving lives. It appears that the NSS is soon to be thrust into a leadership role with regard to educating the general diving public to the hazards of cave diving. The NSS carries a lot more weight as a national organization that is larger than most of the scuba-diving instructor agencies.

The Cave Diving Section of the NSS has clearly established itself as the dominant presence in the Cave Diving community. The CDS is at least twice as large as the other two cave-diving associations combined. Interestingly, both other organizations have struggled, largely in vain, to establish their particular agency as serving a national constituency. Both have remained predominantly regional organizations due to the lack of an affiliation with a larger national agency. In fact, the roots of the creation of the Cave Diving Section lay in a personality and ethics conflict (the proverbial hatchet has long since been buried) between several key individuals among the Section's founders and the leadership at the time of one of the other cave-diving organizations. The NSS took these people in and allowed the creation in the mid 70's of the Cave Diving Section of the National Speleological Society. The Section has grown and become the largest internal organization of the NSS. The CDS will certainly continue to become a much more significant presence in the NSS. We will be able identify ourselves as cave divers and not have the dry cavers say, "You guys are crazy!" Alas, Danny, folks with your approach are still part of the problem rather than part of the solution.

Perhaps the problem is as simple as the old adage of the wood-burning stove. There was a man who wanted heat from his stove. He was cold and felt left out from the group of folks who had heat. However, he suffered from a perspective problem. He kept saying, "Stove, give me some heat and I will give you wood."

Sadly, he remained cold, and he continued to feel left out. ■