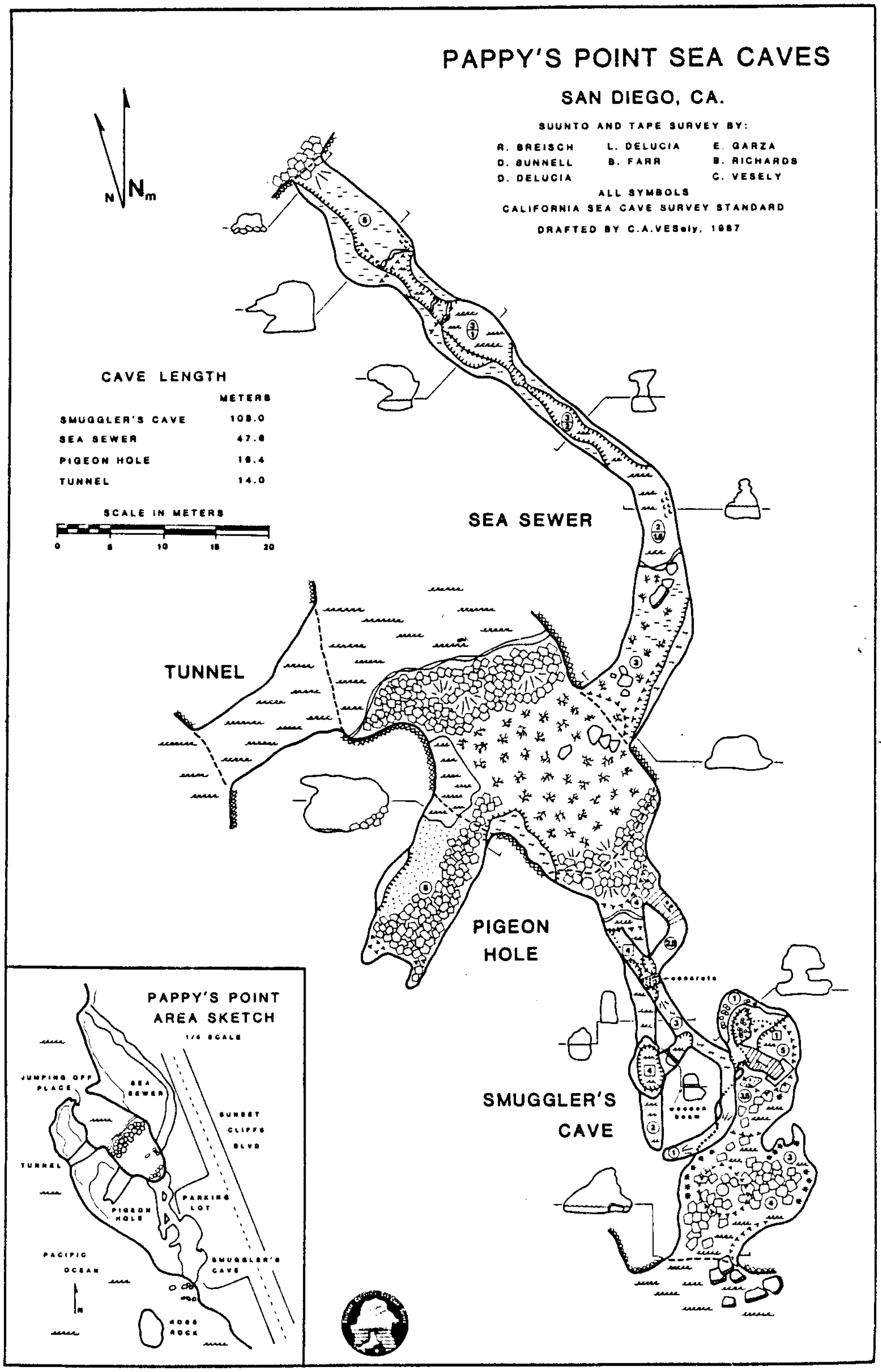
COMPASS & TAPE

Volume 5
Number 1

Summer
1987



COMPASS & TAPE

Volume 5 Number 1 Summer 1987

COMPASS & TAPE is the quarterly newsletter of the Survey & Cartography Section of the National Speleological Society, Cave Ave., Huntsville, Alabama 35810, U.S.A. The cost is $4.00 per year for 4 issues. Please make checks payable to Survey & Cartography Section. Include your NSS number for Section membership. Foreign members and subscribers are **welcome!** Rates are US$4.00 per year for surface mail: inquire for air rates. We regret that payment must be in US$, and checks drawn on U.S. banks. The volume runs from the annual NSS Convention: those paying later will receive all back issues. Expiration dates are printed on mailing labels. Volumes 1, 2 and 3 are available for $5.00 each.

Survey & Cartography Section - 1987/1988

Chair: John Ganter, address below.
V-C: Doug Medville, 11762 Indian Ridge Rd, Reston VA 22091 703-860-0134
Sec: George Dasher, 109 Shawnee Dr, Buckhannon, WV 26201 304-472-6264

Dues, Subscriptions, Articles, Maps, Letters, Address Changes, Comments, Tips, Photos:

John Ganter
Editor, Compass & Tape
Department of Geography, 302 Walker Bldg.
The Pennsylvania State University
University Park, PA 16802 USA
H: 814-237-7841 O: 814-865-6421
BITNET: GL0 @ PSUVM

Submissions: Short items may be in any form. Articles: Disks are preferred. Send 5 1/4-inch DOS Double or High-density, with ASCII, Word, Wordstar or Word-Perfect Files. Modem service is not available. Hard Copy: Should be in black ink, fixed pitch; typewriter or daisy-wheel preferred. Dot-matrix must be large and highly legible. Illustrations: Are strongly encouraged! Camera-ready copy is appreciated and should be designed for reduction. Contact the Editor if you have any questions or special requirements.

COVER: Pappy's Point Sea Caves by Carol Vesely. Used as part of a tourist attraction in the early 1900s, and later for smuggling and bootlegging operations, these caves have a colorful past. From BETTER CAVES & SINKHOLES (Santa Barbara Underground Grotto) 3:2, Summer 1987.

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Text Processing Courtesy of the Department of Geography, College of Earth & Mineral Sciences, The Pennsylvania State University.

The Transit-Survey Myth

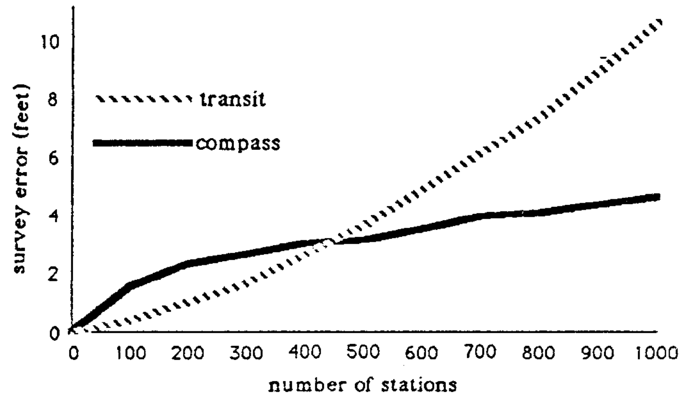
by Bill Mixon
Austin, Texas

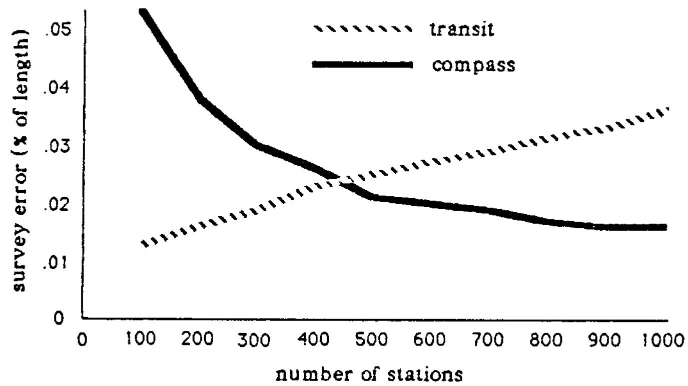
While reading the report of the Bighorn Caverns Project, which remapped that Montana cave in 1985 and 1986, I was reminded of the mistaken respect many cavers seem to have for transit surveys. This is no doubt due to the deceptive precision involved in reading angles to, say, the nearest half-minute of arc, which is commonly and easily done with those instruments. I believe "transit" surveys are in fact usually done with theodolites, but I am not sure just what the difference is between those two instruments.** The remarks which follow apply to what cavers mean by a "transit survey;" that is, one in which turning angles measured with a surveying instrument substitutes for the compass and clinometer, but that otherwise resembles an ordinary cave survey. Large-scale land triangulations are another question entirely.) The fact is that a cave survey of any substantial length will be more accurate when done with conventional compass-and-tape than with fancy surveying equipment.

To demonstrate that fact, I ran a simple numerical experiment on a computer. I calculated the accumulated error in the survey of a random horizontal cave with both instruments. The cave had one thousand survey stations, with each true distance selected randomly and uniformly in the range 10 to 50 feet and each true azimuth selected randomly and uniformly in the range 0 to 270 degrees. Restricting the range of azimuths makes the cave actually go somewhere; qualitatively similar, but a bit less dramatic results are gotten if the angles are distributed around the entire circle. To each distance measurement in the compass survey, I added a random error between plus and minus 0.1 feet; to each distance in the transit survey, I added a random error in the range plus or minus 0.01 feet, assuming use of a real surveyor's chain. To each compass reading I added a random error between plus and minus 0.5 degrees; to each transit angle I added a random error between plus and minus 0.5 minutes, sixty times smaller than the assumed compass error. The total survey error at each hundredth station was calculated. I ran one hundred such experiments and averaged the results. (Aren't computers nice?) The result is tabulated below.

Number of Stations	Average Error in Feet Compass	Transit
100	1.6	0.4
200	2.3	1.0
300	2.7	1.7
400	3.1	2.7
500	3.2	3.7
600	3.6	4.9
700	4.0	6.1
800	4.1	7.4
900	4.4	9.0
1000	4.7	10.7

The slight irregularity reflects the fact that random walks are seldom "typical," that is, while their average properties can be calculated, the spread is quite large. More than 100 trials would have smoothed the curves more. The results, which are also shown in the accompanying graphs, are nevertheless clear and perhaps rather surprising. Despite ten times better distance measurements and sixty times better angle measurements, the transit does little better after only a couple of hundred stations, and actually is worse, by an accelerating margin, after five hundred. What is going on ?





The answer lies in the way angles are actually obtained in the transit survey. After somehow determining the direction from the first station to the second (more on that later), the instrument is placed at the second station and the difference in the directions to the first and third stations is read, which allows calculating the actual direction to the third station. Then the difference in directions from the third station to the second and fourth is read, from which is derived the azimuth between the third and fourth, and so on. An error in any direction measurement influences all subsequent azimuth calculations, since every azimuth is calculated as, essentially, the sum of all preceding angle readings, whereas in a compass survey, the azimuth errors, though larger, each affect only one leg of the survey. It is the accumulation of azimuth errors over many stations that accounts for the fact that transit surveys become less accurate as they proceed, whereas the random compass errors tend to cancel out to some extent. So a compass survey becomes more accurate, percentage-wise, the longer it gets.

Of course, my simulation doesn't really reflect the true accuracy of the typical cave survey. Compass surveys more often quote errors, where closures are available. of around 0.5 percent, not less than one-tenth of that. This is presumably due to blunders-- reading or recording errors, misunderstandings among party members about station locations, and the like-- and non-random errors that result from, for instance, using uncalibrated compasses or stretched tapes. Also, I am assuming that there is no station-position error, that is, the instrument is always placed exactly at the point just sighted to. In the case of compass surveys, random station-position errors behave like compass or distance errors; they tend to partially cancel. In a transit survey, station-position errors contribute an extra component to the angle errors, which accumulate. Whether transit surveys come closer to even their theoretical accuracy is doubtful. I find it hard to believe that station-location errors of under one-hundredth of a foot are attained under cave conditions, for instance, and of course a single angle blunder has drastic consequences.

Since any direction error in a transit survey affects every subsequent shot, the direction of the ***first*** shot is very important. In a compass survey, the first shot is just another shot. But if a compass is used to give the direction of the first shot in a transit survey, then the absolute positions of distant points in the survey will be seriously affected. For instance, a quarter-degree error in the first direction would alone result in an error of 23 feet in the position of a point one mile away. This will not affect closures within the cave, of course, which can be good, in that promising locations for connections and such will not be spoiled, and can be bad in that a false impression of overall accuracy will be obtained from in-cave closures. I wonder how many transit surveyors actually make sure their first angle is as good as all the others, which would require a carefully timed sighting on the North Star.

I doubt if very many cave surveyors have seriously considered making a transit survey five hundred stations long. They needn't feel guilty about their laziness.

** [Editor's Note: The distinction between transit and theodolite seems to be rather vague in the surveying and civil engineering literature. ***Transit*** often refers to a telescope-sighted compass, with graduations read by vernier. ***Theodolites*** tend not to have compasses, have either graduations read with microscopes or digital readouts, and are used as Bill describes.)

Hold The Light A Little Closer

by Russell Gurnee
Closter, New Jersey

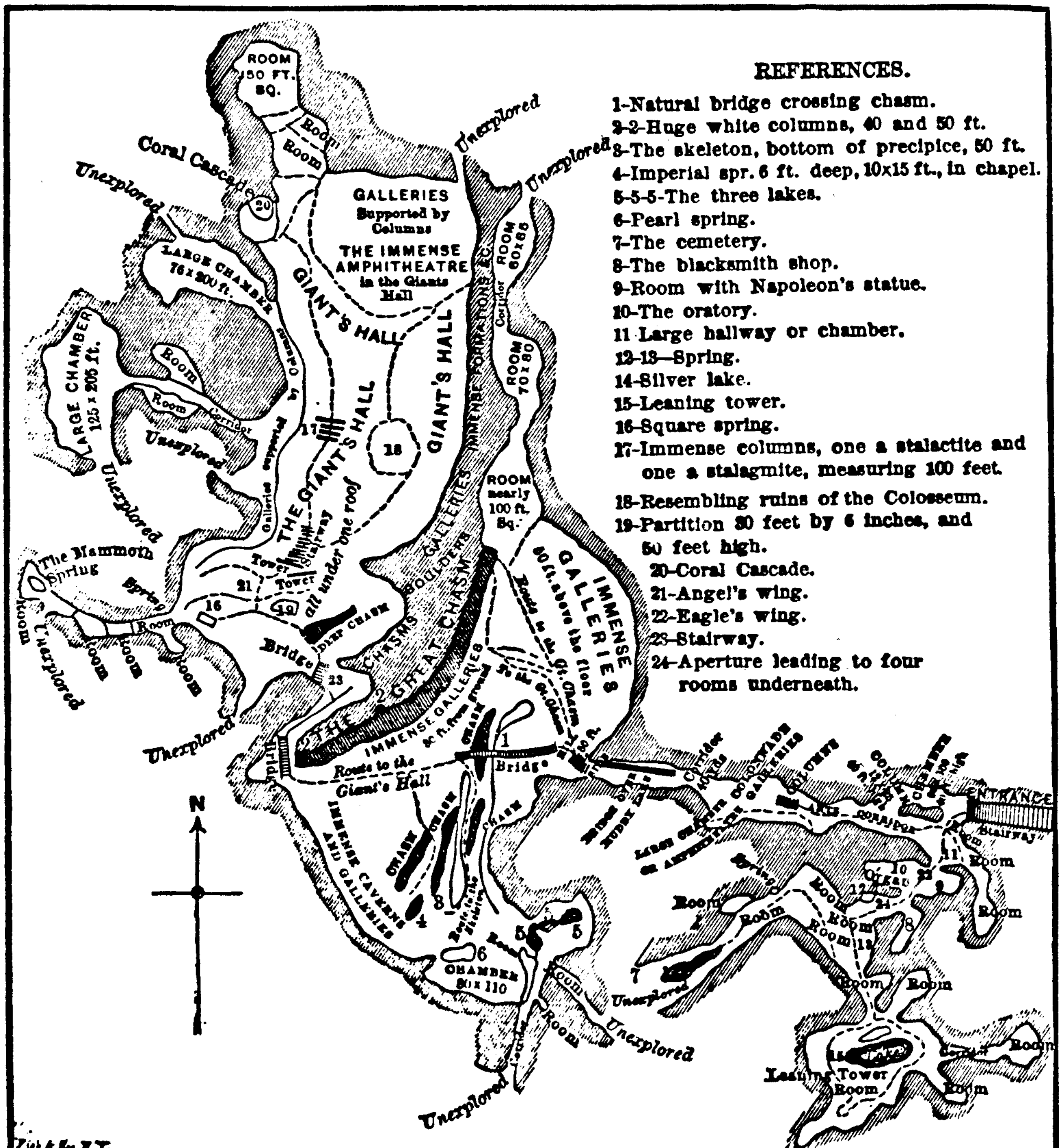
Luray Caverns, Virginia, was discovered on August 13, 1878. In three months it was mapped by two "experts" and the published results differed greatly.

Map number one was done by Alexander Y. Lee, a civil engineer from Winchester, Virginia. His map was published in the New York Herald on November 12, 1878 and included "improvements" to the cave such as stairways, bridges, trails, and boardwalks. He was accompanied by Major Alexander J. Brand (author of the report) and Andrew Campbell discoverer of the cave.

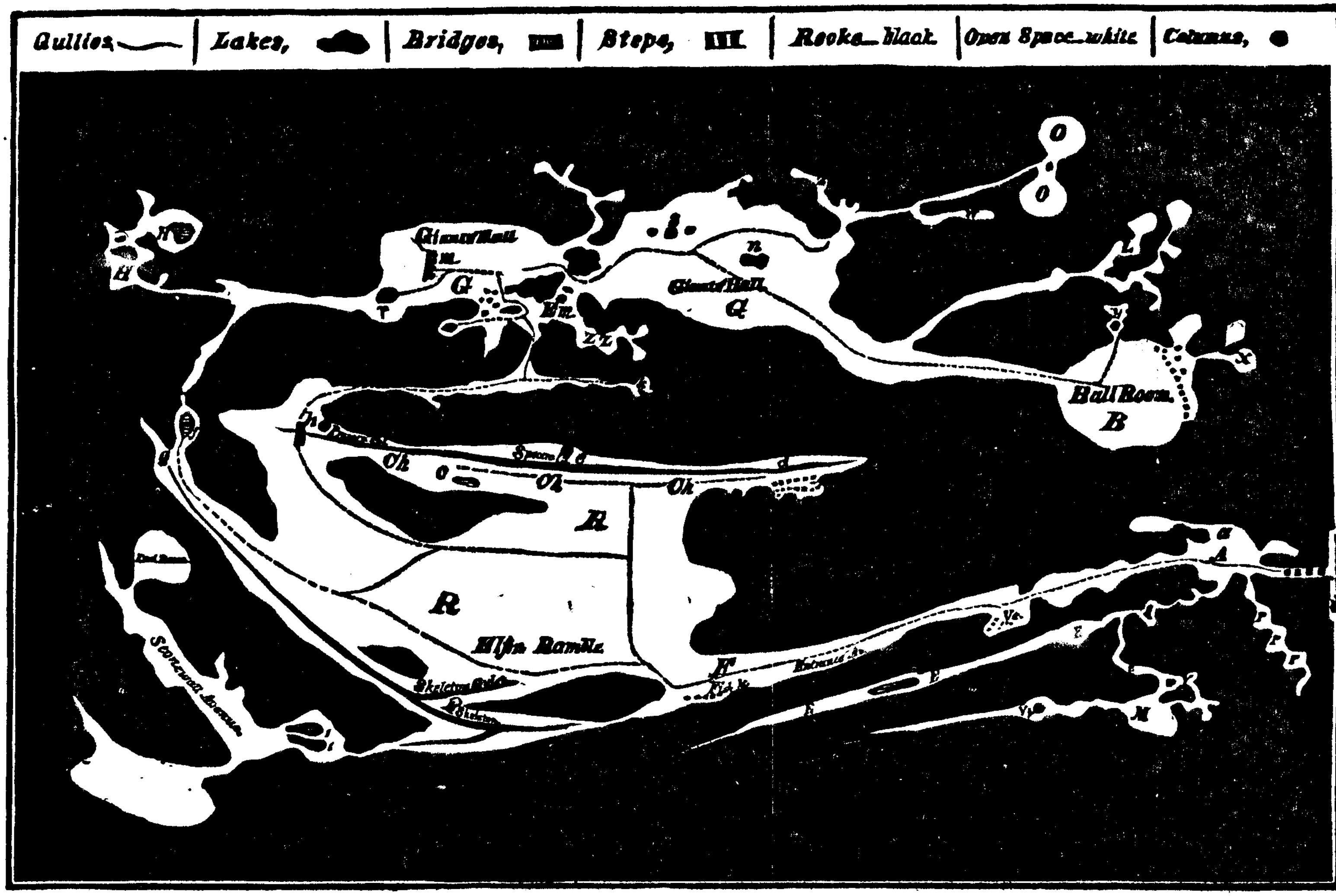
Brand's story received national attention. However, Gordon Bennett, Editor of the Herald, decided to replace the freelance Brand and send his "scientific correspondent" Jerome J. Collins to take over this big story. Collins, an Irishman, had a way with words and a touch of the Blarney. He had an engineering background, (he did the weather reports for the Herald) and proceeded, during the week, to survey with Campbell the unexplored leads on Lee's map.

In a week, he wrote three stories on the cave, then Bennett sent him on to his next assignment as part of the crew of the DeLong expedition aboard the "U.S.S. Jeannette" enroute to the North Pole. He left his notes and preliminary sketch with Andrew Campbell then packed his bag and left.

Collins shipped aboard as "scientific observer" for the New York Herald. The tragic story of the loss of the vessel in the Baltic Sea and the terrible journey across Russia has been told in the story of the DeLong Expedition, HELL ON ICE, by Commander Ellsberg. Collins perished in a snowbank on the Lena River.



Alexander Lee Map No.1



EXPLANATION OF THE MAP.

BEGINNING AT THE STAIRWAY ON THE RIGHT.—*A*—Entrance Hall containing, at *a*, Washington's Column; *B*—Amphitheatre, or Ball Room; *F*—Fish Market; *R R*—Elfin Ramble; *Ch Ch*—Pluto's Chasm, traced with a broad black line; *e*—The Spectre; *c*—Mirror Lake; *h*—Proserpine's Column; *d*—The Balcony; *k*—Oberon's Grotto; *m*—The Organ; *p*—Chapman's Lake; *s*—Sultana Column; *n*—Double Column; *y*—The Cascade Spring, adjacent to the Amphitheatre; *X*—The Grotto; *L*—Campbell's Hall; *Z Z*—Former Bridal Chamber; *f*—Imperial Spring; *g*—Brand's Cascade. At *Vc*—is the Vegetable Garden. At *Em*—is the Empress Column.

E E E E—Stebbins' Avenue; *M*—Stebbins' Hall; *V*—Leaning Tower; *V V*—Bayonet Well. *P P P*—Specimen Avenue. In Stonewall Avenue. *t t*—The Twin Lakes or Brothers. *H H*—Hades; *l*—Lake Lethe. *Z*—The Toys; *w*—Crystal Room; *O O*—Erebus It is not claimed that the Map is more than approximately correct as to relative distances. Very many details are omitted for the sake of simplicity; and, to prevent crowding, but few objects are designated. The dotted lines indicate the routes open to visitors previous to 1880. Other parts are now accessible.

Jerome J. Collins Map No. 2

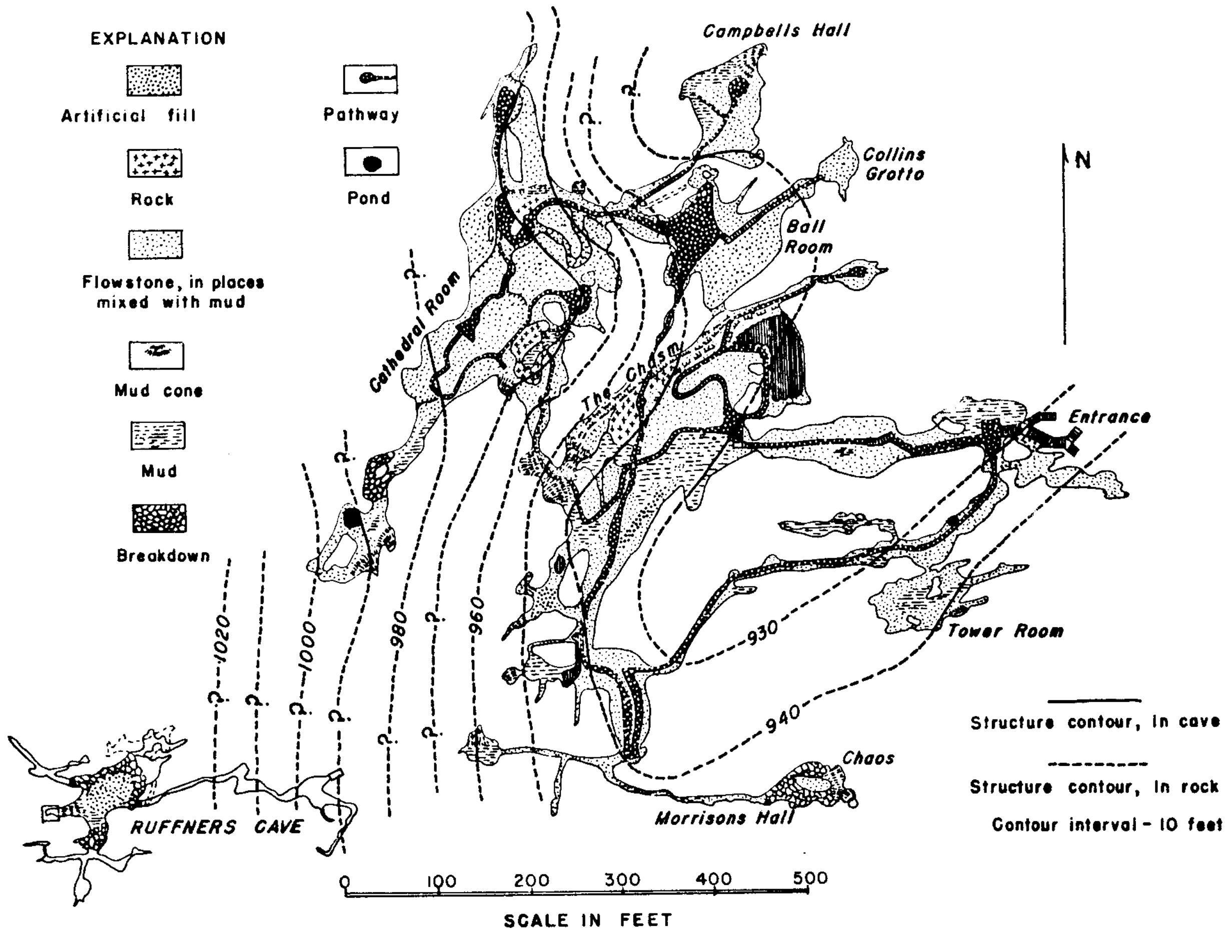
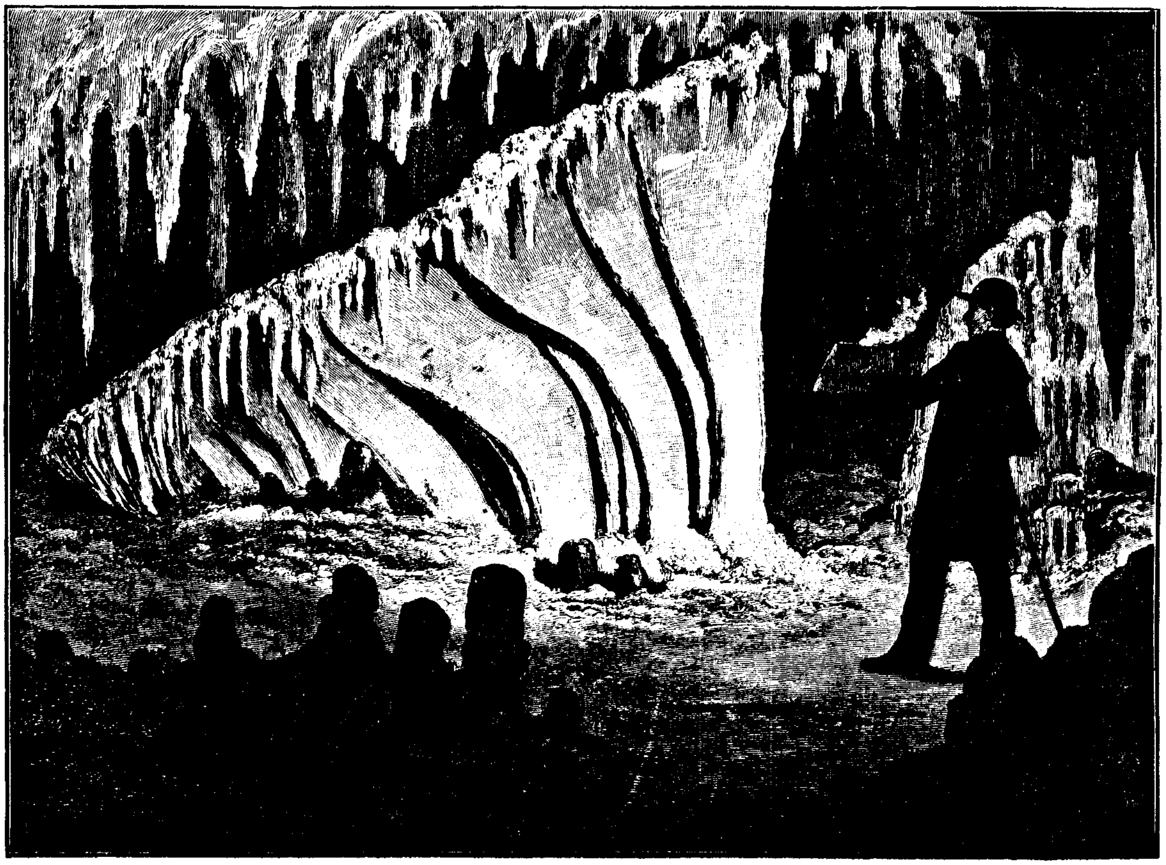


Figure 6. Map of Luray Caverns and Ruffners Cave showing cave deposits and structure. Contours in eastern part of cave are drawn approximately 3 feet above the base of section 2. In western part contours are inferred to be at this horizon on the basis of dip-and-strike measurements. Elevations are in feet above sea level.

Hack and Durloo Map No. 3

NSS Committee On Long & Deep Caves

Bob Gulden's latest release, which appeared at Convention '87, is 12 pages long and contains 6 lists: Caves of the USA Over One Mile Long; USA Long Cave Statistics; Caves of West Virginia Over 1500 Feet; World's 100 Longest Caves; World's 100 Deepest Caves; Deepest Caves of the USA. To obtain a copy, write: Bob Gulden, 1333 Chapelview Drive, Odenton, MD 21113. 301-674-4474. The Committee operates under the auspices of the NSS Section on Cave Geology & Geography (often known as GEO2), and invites contributions of information, updates and corrections.



His notes and map appeared in 1880 in S. Z. Ammen's Guide book for Luray Caverns. (See map two) The cave features were named by Horace C. Hovey in his visit to the cave in 1879 after Collins left.

In defense of Collins, he probably did not know that his compass readings were influenced by the three-candle sconces made by Andrew Campbell, tinsmith. In his description of his mapping he talks of uncertain readings that he suspected might be because of the "iron in the soil". We can only speculate that his map was considered by some to be better than Alexander Lee's map which was done in only one day.

Map three shows the current 1962 map by Hack and Durloo in the GEOLOGY OF LURAY CAVERNS, VIRGINIA report.

The comparison of the three maps shows the problems and difficulties that can plague underground surveys.

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1. HACK, JOHN T, and Leslie H Durloo, Jr. (1962)
GEOLOGY OF LURAY CAVERNS, VIRGINIA
Virginia Division of Mineral Resources
Charlottesville, Virginia

2. THE PAGE COURIER, Luray, Virginia (1875 to 1888)
August 13, 1878 to January 19, 1879

3. NEW YORK HERALD, James Bennett, ed. (1878)
October 19, 1878 to November 28, 1878

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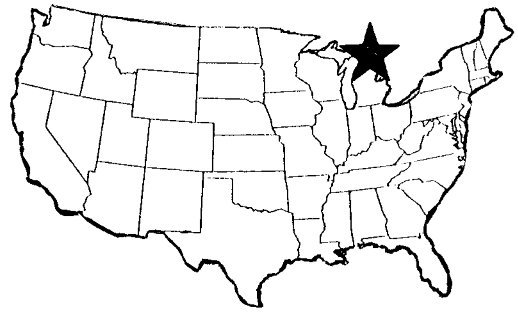
HISTORY AND DISCOVERY OF THE LURAY CAVE,
J. W. Borst, Baltimore, MD

1987 SACS Session

NSS Convention, Sault Ste. Marie, Michigan

Coordinator: Dan Crowl

Grosse Pointe Woods, Michigan



Controlling Survey Accuracy

Ray Cole NSS 12460 3410 Austin Court, Alexandria, Virginia 22310

In completing a large cave report like ***Caves of the Organ Plateau*** (West Virginia), the first question asked by a potential user of the caver-produced surveys is about the relative accuracy of the passages and geological features. To help control the levels of error and estimate their magnitude requires a combination of accurate surface surveys, cave radio locations, and computer processing. A method was developed for estimating potential survey error based on the string closure adjustments of the highly-constrained survey data.

Working Drawings for Show Cave Development

Russell H. Gurnee 231 Irving Avenue, Closter, New Jersey 07624

Preparation of construction drawings for any project assumes a working knowledge of special techniques by the Architect and an understanding of the work by skilled tradesmen. These skills are not delineated in the plans, but they must be mutually understood, or the basic design may not be achieved. Good design is of signal importance; without it the best workmanship may be in vain.

Show cave development is the modification of a natural cave to provide a supervised, safe, and satisfying educational experience for the public. There are less than 700 caves open to the public in the world today. However, there are three times that many that were opened, modified, then closed. There are no schools or classes to aid the aspiring designer. In fact, most of the caves open to the public have been first-time efforts of the designer, architect and workmen... Sort of a do-it-yourself brain surgery.

None of this would be important if the caves so selected were ordinary, or expendable. Unfortunately, each one is unique and has been selected because it is distinctive.

This paper will describe the operational program used by the author on three projects where the design was the result of the cooperation of individual specialists to achieve the best results. The work drawings and specifications will be available to show the relationship of the designer to the work crew.

Plans and specifications for the following caves: 1) Harrison's Cave, Barbados, W.I.; 2) Rio Campy Empalme Cave, Hatillo, Puerto Rico; 3) The Fountain, Anguilla, British West Indies.

The Ohio Cave Survey

Horton H. Hobbs 601 White Oak Drive, Springfield, Ohio 45504

For the past eight years the Ohio Cave Survey (OCS) has been an active organization. Physicochemical and biological sampling have been important aspects of the OCS as well as surveying. The caves of the state have never been documented other than in lists made by a few individuals, thus much above)ground as well as subterranean field work has been and continues to be a necessary part of the OCS. At present, 107 caves have been mapped or are in various stages of completion. Many of the maps have been published in the Wittenberg University Speleological Society journal, ***Pholeos.***

Progress Report on CMAP 15

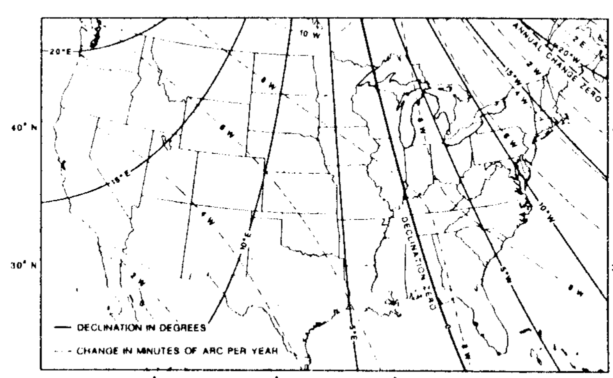
Robert Thrun 8123 14th Avenue, Adelphi, Maryland 20783

CMAP 15 is a microcomputer version of a cave survey data reduction program that had been successfully used on a mainframe. Much of the program was rewritten from scratch to adapt it to the microcomputer environment, and to make it faster and more compact. The input format is more flexible. Station matching is faster. The data storage is more compact. A simple plotting program is available. It uses a dot-matrix printer as a plotting device. A much more flexible plotting module is being converted and rewritten.

Geomagnetics News

For all you aspiring geophysicists and geodesists, the USGS has released new multivariate models of the magnetic field, based on a large number of recent measurements. Support in the form of FORTRAN programs and a dial-up WATS line is designed to help make use of these. Write: National Geophysical Data Center, NOAA, Code E/GC4/FLI, 325 Broadway, Boulder, CO 80303. The map reprinted here is one result of these new 1985 models.

(From ***EOS,*** vol 68:20, 19 May 1987, p. 530. Contributed by Joe Troester.)



A SMAPS/Autocad Interface

by Jim Nepstad
Wind Cave National Park

Computer-aided-design (CAD) has long been possible only with large mainframe or minicomputers. Microcomputers lacked both the speed and the mass storage capabilities which were required to produce completely digitized cave maps. Things have changed drastically over the last few years, however, and there are now several CAD software packages specifically designed for the IBM PC/XT/AT and compatibles on the market. Most of these programs are very capable, offering 80% (or more) of he features offered by their mainframe equivalents. The most popular of these is AutoCAD, published by Autodesk, Inc.

For reasons which will be described in a future article, we at Wind Cave National Park have decided to digitize the map of Wind Cave, a 50 mile long system. To analyze the data (over 10,000 survey stations worth of it) we chose Doug Dotson's program SMAPS, and to draw the map we opted for AutoCAD. What follows is the description of a program which will interface these two software packages.

The first step in producing a digitized drawing of a cave is entering coordinates. As mentioned above, Wind Cave presently contains over 10,000 survey stations. Manually typing in the coordinates would be a tremendously time consuming and tedious task. It was therefore desirable for us to develop a program which could read in the coordinates produced by SMAPS and rearrange them into another file which AutoCAD could use to automatically create a drawing of the survey stations, the traverse lines running between them, and the survey station names. The name of this program is SMAPCAD.

SMAPCAD requires ASCII files containing analyzed survey data. The SMAPS "U" function can be used to create such a file. The program reads in this data and creates an AutoCAD ".DXF" file. Without going into too much detail, a .DXF file is a specially formatted ASCII file which AutoCAD can use to create drawings. Running SMAPCAD is as simple as entering two file names. Once it is done executing, simply perform the AutoCAD "DXFIN" command and a drawing will appear before your eyes (one that could easily have taken hours or days to produce by hand!).

The drawing SMAPCAD produces contains a triangular symbol at each survey station, traverse lines, and station names. Each station is assigned to a particular "layer" of the drawing, based on elevation. Thus, certain layers can be temporarily turned off in vertically complex sections of the cave to increase readability. All station names are placed on the same layer so that they too can be turned off if need be.

Obviously, a lot of work is still to be done before the map is finished. Passage outlines and internal details have to be digitized by hand. But at least the most tedious work involved in producing a digitized cave map can be done automatically. It is estimated that this program will save us several hundred hours of keyboard time.

One of the promising features of the program is that it may be useful with other CAD packages. AutoCAD is the industry standard, so most other CAD programs can import AutoCAD drawings. If you have access to another program which will accept AutoCAD .DXF files, this program will also work for you. There are many CAD programs on the market now costing less than $200, GenericCAD and ProDesign II just to name a couple. Both of these programs allow for the importing of AutoCAD drawings, but possibly at an extra cost.

Copies of SMAPCAD can be obtained by sending a DSDD 5 1/4" diskette (or $1.00 to cover the cost of one) to: Jim Nepstad, Wind Cave National Park, Hot Springs, SD 57747. The program was written in BASIC (not compiled) so slight modifications are possible if you desire. Copies (of the original only please) can be made to give to any others who may want one.

1987 SACS Annual Meeting

The meeting was held on Wednesday, August 5, 1987 at Lake Superior State College, Sault Ste. Marie, Michigan. Chairman John Ganter called the meeting to order at 1220 hours.

Chairman's Report: We have a number of new members overseas following an advertising campaign. The Treasurer has resigned and the Chair has assumed his duties. Membership stands at about 180.

Treasurer's Report: We seem to be solvent, but the books are a mess. The Chair is working on the problem.

Editor's Report: There were fewer unsolicited submissions in the past year, and less material to reprint. We are looking for a new editor. It is felt that the job requires good production and printing facilities, and a willingness to write and actively solicit material. One individual has expressed interest, but does not feel that he would write and twist arms. A general discussion was held about damaged mailings, but these were not deemed large enough to worry about. Bob Hoke will provide a mailing list from the now-defunct Computer Applications Section.

Old Business: Bill Nelson is making arrangements with Ernst Kastning to transfer the maps donated to the ***Map Salon*** to the NSS Library. It is not yet clear if the Library has room for these.

Cave Map Symbols: Dave West moved that the symbols as reported by the symbols committee be accepted and the Committee be directed to tie up the loose ends. Fred Grady seconded. Vote: 4 FOR, 10 AGAINST, 3 ABSTAIN. FAILED.

Bob Hoke moved that the Survey & Cartography Section (SACS) endorses Page 1 of the joint committee's report (attached) as a subset of a more comprehensive list still in development. Paul Hill seconded.

Calvin Alexander moved to defer Hoke's motion until the philosophy of a short vs. long list was settled. West seconded. PASSED unanimously.

Alexander moved that SACS recommends that there be a basic list and a separate longer list which, if used, should be identified on the map. Alternate symbols on along list would be acceptable. George Huppert seconded. PASSED unanimously.

Hoke's motion was then returned to the floor. Hoke accepted a friendly amendment: Change "as a subset of a more comprehensive list still in development" to "as the Basic Symbols List." PASSED unanimously.

(Note: These same two motions were then passed the following day at the ***Section on Cave Geology & Geography*** meeting with the appropriate change in the Section name.)

Officers elected in 1987: John Ganter, Chair & Treasurer. Doug Medville, V-C and 1988 Session Chair. George Dasher, Secretary.

Meeting adjourned at 1345 hours.

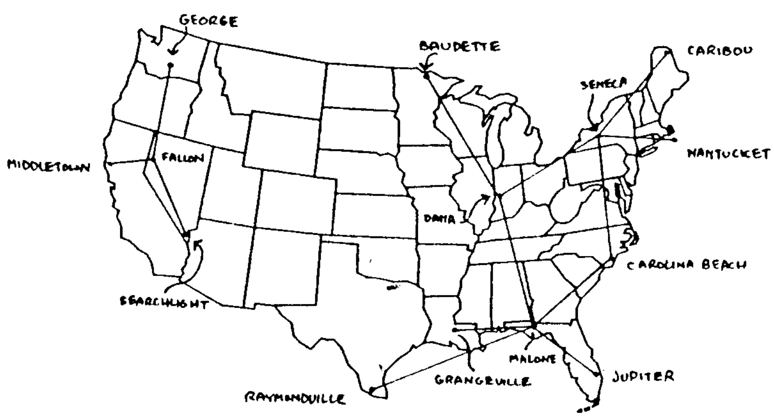
Minutes submitted by David R. West, Acting Secretary.

LORAN-C For Cavers (Updated)

by Frank Reid
Bloomington, Indiana

Four years travel with a LORAN-C electronic navigation receiver have shown that its high resolution (0.01 minute of latitude/longitude, roughly 50 x 60 feet) and repeatable accuracy (typically 100 feet in primary-coverage areas) are adequate for locating and returning to small karst features in Kentucky and Indiana in dense woods where visibility is 100 feet or less. Mobile and portable LORAN is useful for finding caves in normal or rescue situations, and for navigation to conventions. I have also used it in conjunction with cave-radio survey.

LORAN is an acronym for LOng RAnge Navigation. LORAN-C receivers compute latitude and longitude by receiving precisely-timed pulses from widely-spaced fixed transmitters (Fig. 1). They compute such useful navigation functions as distance-and-azimuth to destination, true course, ground speed, cross-track error, cumulative distance, ETA, and "velocity made good" (the component of motion toward the destination). They also display raw LORAN coordinates in microseconds, for those secret cave locations!



Loran-C stations in the continental U.S. Obviously, they favor coastal areas.

The system is maintained by the U.S. Coast Guard, and is extremely reliable. The low-frequency (100 kHz) signals propagate by groundwave, around the curvature of the earth, so LORAN works at any altitude. Once calibrated, a receiver can initialize without need for operator input of known coordinates, and can do so while in motion. All LORAN-C stations are on the same frequency, transmitting pulses in different time frames. Stations are grouped into "chains" of a master and two or more secondaries. Three stations of a chain must be received to compute a fix. The receiver selects the desired chain by its group repetition interval (GRI). Most receivers can automatically select the best chain and secondaries for a given area.

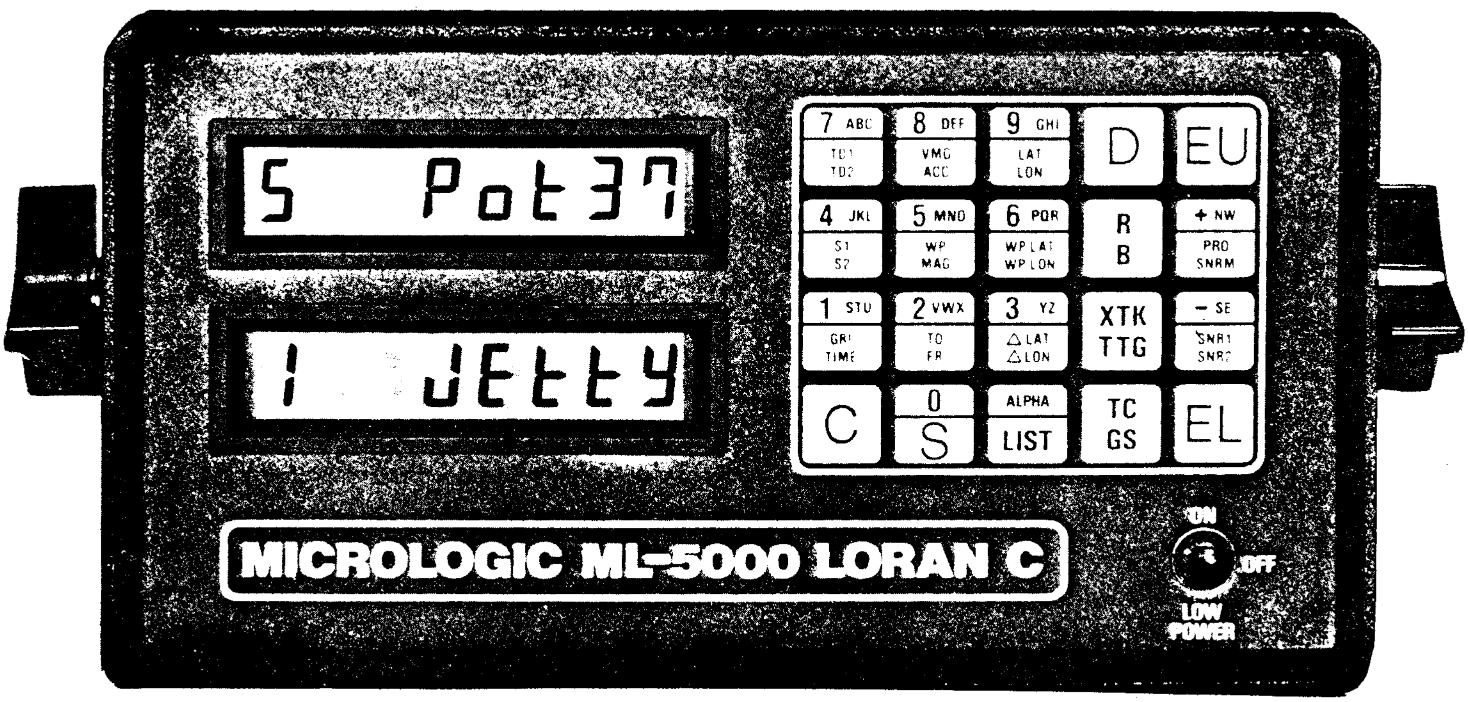
The advent of 16-bit microprocessors made LORAN-C receivers affordable. They continue to become smaller, more sophisticated and less expensive (now about the price of a good car stereo system). Some receivers have internal batteries for hand-carried portable operation. Others can be backpacked. They are an aid to surface karst studies, and to cave rescue. LORAN-C receivers made for boats are least expensive, and are relatively weatherproof.

Given a LORAN receiver, thinking in latitude and longitude becomes easy. The spherical coordinate system has many advantages but many cavers consider it cumbersome. Programmable pocket calculators can convert lat/lon to UTM or other coordinate systems.

Most LORANs display distances and speeds only in nautical miles and knots (nm per hour). Nautical miles are practical units for lat/lon navigation- A nautical mile is one minute of latitude (6076 feet, 1.15 statute mile). It is approximately 2 kilometers or 2000 yards. King Radio's model 8001 will indicate nm, statute miles, or kilometers. (The 8001 is probably the current best buy at $600-700.) LORAN receivers are available from aircraft and marine electronics dealers. Prices are competitive; see ads in Trade-A-Plane and Motor Boating and Sailing magazines.

LORAN receivers require one to three feet of antenna, which must be connected directly to the antenna preamplifier (sometimes a separate unit). My antenna is a wire stretched across the inside of a fiberglass pickup-camper shell. Installation must be done carefully to avoid automotive electrical noise.

My Micrologic ML-5000 receiver has been altogether satisfactory for automobile use, probably a worst-case application. I've measured locations of 200-mile-distant road intersections on aeronautical sectional charts, and consistently had the waypoint- arrival alarm sound when within sight of the destination (arrival alarm radius set to 300 feet). The ML-5000 stores 59 locations, called "waypoints." Its unique ability to store alphanumeric waypoint names is a



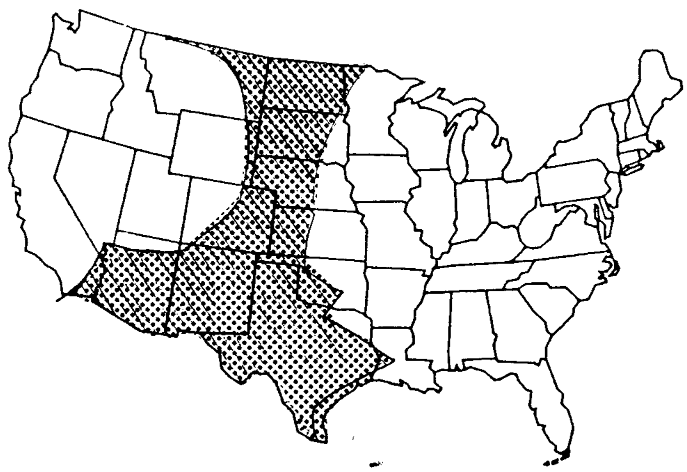
tremendous advantage, eliminating the need to refer to a separate list. Waypoints are entered as latitudes and longitudes in degrees/minutes/seconds, or degrees, minutes and decimal fractions of a minute. Present position can quickly be stored in an empty waypoint. The ML-5000 knows magnetic declination everywhere, given the current year.

It's an excellent companion on long drives. I named mine "CRM-114" after a device in the movie ***Dr. Strangelove.*** One of my stored waypoints is MECCA, for the convenience of any Moslem passengers.

Another LORAN I've used, a II Morrow "Apollo" installed in a friend's airplane, has relatively primitive software and is unsuitable for caving.

Power lines are the major source of interference on land. Briefly driving under one causes no problem because the computer's position-determining process averages a large number of LORAN pulses. Driving parallel to a large power line for a mile or so can cause the receiver to lose track, requiring a few minutes to re-initialize. It sometimes becomes unusable in metropolitan areas.

LORAN performance varies with position relative to transmitting stations. Great Lakes and coastal areas, including all the area east of the Mississippi, are well-covered. Weak signals and unsuitable station geometry make LORAN-C marginal or unusable in parts of the Western Plains and Southwest. Signal quality is considered unsuitable for instrument flight in the "mid-continent gap" (Fig. 2), however, LORAN continues to work with decreased accuracy in most of that area. I have found the system unusable in the Black Hills of South Dakota, the Carlsbad area of New Mexico, and in Texas south of Dallas. New transmitting stations are planned, which will fill the "gap." The Navstar satellite navigation system is superior, providing worldwide coverage with constant accuracy, but receivers for it may not become affordable soon.



The mid-continent gap. This map is based on certain assumptions about receiver performance.

Of course, I experimented with LORAN underground. I carried my unit (with 3-foot whip antenna) through a large commercial cave in central Kentucky which contains USGS benchmarks, stopping at benchmarks to check position. The average depth was 200 feet. Signal strengths varied enormously-- At many locations, signals from the 400-kw station at Dana, Indiana (173 nautical miles away) remained almost as strong as on the surface but signals from New York and Florida were unusably weak, so fixes could not be computed. 100 feet of extra antenna did not improve reception significantly, nor were weak-signal procedures successful. At a place where water enters the cave through a vertical joint, all signals were strong; the computed fix was 1/2 mile east of the true location. Part of the underground route contained power lines for lighting, which are in metal conduit and buried. Their presence or absence had no noticeable effect on LORAN signals. The lights were not turned on. I have taken the receiver into two Indiana caves, with similar results.

Although LORAN navigation seems not to work underground, there are interesting effects worthy of study; a simplified 100-kHz receiver could be used in caves to search for vertical joints, thin overburden or other anomalies.

Most helicopters now carry LORAN-C equipment. Supplying latitude/longitude information to air ambulances can expedite a cave rescue but doing so indiscreetly may attract a swarm of airborne news reporters!

[Revised from an article in ***Speleonics 5,*** Summer, 1986]

Suunto Instrument Maintenance

by Ian McKenzie
Jasper, Alberta

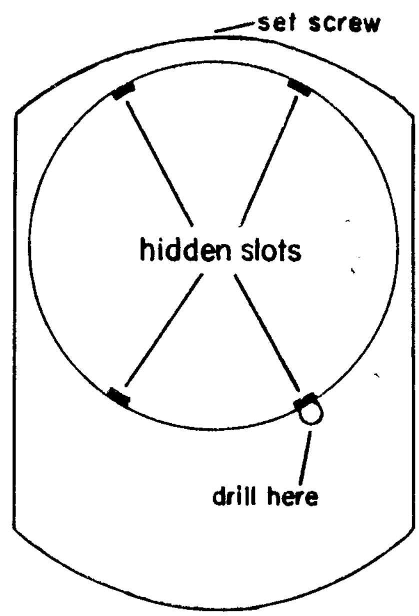
Compasses and clinometers by Suunto are the favored surveying tools of cavers, but occasionally they are rendered useless by dirt or vapour inside the instrument obscuring the sighting port or a large bubble tipping the compass wheel.

A variety of repairs can be effected by disassembling the instrument. The friction-fit circular plate on the back can be removed by drilling a shallow 3mm (1/8 inch) hole in the proper place in the body of the instrument, biting the plate just enough to intersect one of four hidden slots. A small screwdriver can then be inserted under the plate to lever it off. After easing off the red-painted set screw with a jeweler's screwdriver the plastic compass-clino module can be removed.

Dirt and moisture can be easily wiped from the module, and the inside of the eyepiece can be cleaned with a model airplane paintbrush.

Any hairline cracks in the module can be repaired with a soldering gun or hot-knife. Fluid can then be replaced by pushing a hot heated pin through the side of the uptipped module into the bubble, and topping up the fluid with a syringe before resealing the pinhole with a soldering gun. Leave an extremely small bubble in place, as oil in the pinhole will prevent it from being resealed. The only problem is finding replacement fluid, as most light oils are still too viscous and become more so at low temperatures. An obvious solution is to use fluid from another crippled instrument, accessing the fluid from the donor in a similar manner and resealing it to save the remaining fluid for another casualty.

Reassembly is simple, but make sure the module goes back in with the sighting lens facing the eyepiece! Tap the backplate into place with a hammer and fill the drilled hole with epoxy. Finally, epoxy may also be used to properly seal the instrument face and eyepiece, although it is brittle and will need occasionally to be broken out and replaced.



DRILLING
TEMPLATE

(Reprinted directly from *The Canadian Caver* vol 19:1, Spring 1987, p. 42)

More On Suunto Instrument Maintenance

by Doug Medville
Reston, Virginia

I read Ian McKenzie's article about Suunto instrument maintenance in the ***Canadian Caver*** (reprinted herein) and tried to follow his instructions for taking my Suunto compass apart. The lessons that I learned may be beneficial to others who also try to do this.

In his article, McKenzie gives an accurate drilling template and indicates where to drill in order to intersect one of the four hidden slots. What he does not mention is that you have to be extremely careful as to where you drill. You must drill outside of the slot. If you graze the slot even slightly, you will intersect the cylindrical body of the of the plastic compass or clinometer module. When this happens, the internal fluid slowly leaks out, a large bubble results, the card inside gets stuck, etc. Bad news. This cylinder consists of two pieces of plastic joined together around their circumference to form the module, and it is easy to intersect it when drilling. I'd suggest tapping a small depression in the instrument before drilling in order to guide the drill.

I also found that drilling one hole was not sufficient to allow the plate to be pried off with a small screwdriver. Two holes do the trick, but increase the chances of intersecting the module.

The set screw must also be loosened before removing the plate. This screw is coated with an epoxy-like material to prevent leakage into the instrument and does not appear to be red paint. Be careful when trying to get to the set screw -- you don't want to strip the groove in the screw head while digging into this material.

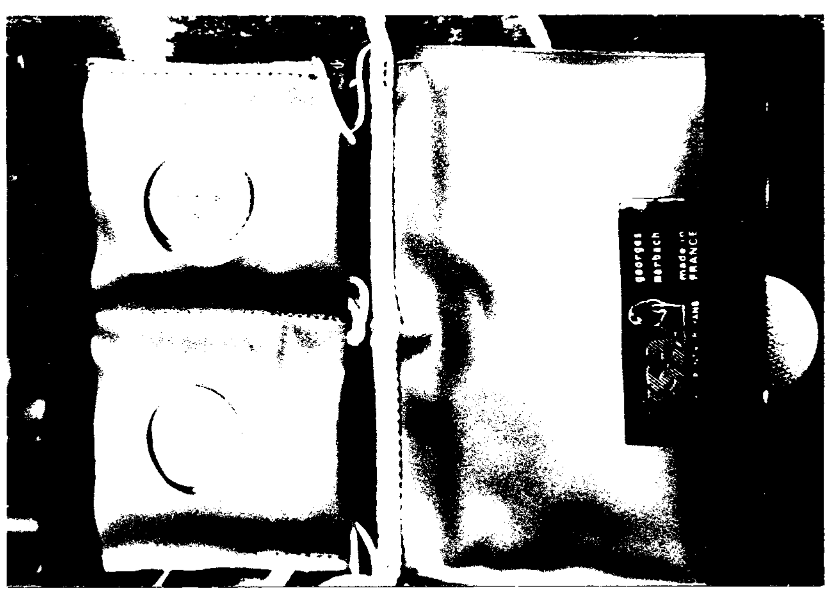
Finally, when you are ready to lever off the friction-fit circular plate, beware! McKenzie didn't mention that beneath this plate is a circular copper disc that is normally deformed/curved so that it does not lie flat. The circular plate above it flattens this disk and holds it (and presumably the module below it) in place under pressure. When you pop the plate, the copper disk will fly off into the air this was unexpected and the thing almost hit me in the face.

So, after doing these things, you are finally ready to clean out the inside of the instrument and then reassemble it, following McKenzie's instructions. This is easy to do. Good luck.

[Editor's Note: See "Suunto Surgery", ***Compass & Tape*** vol 2:1, Summer 1984, pp. 4-6 for a photo-illustrated tour of Suunto internals. It sounds as if the design has changed somewhat since those instruments were dissected. The module was held in place by two light copper rings, which were under very little compression.]

TSA Instrument Case

Inner Mountain Outfitters (Alex Sproul) is now importing a padded vinyl case, with a velcro-closed cover, which holds and protects a compass and clinometer. The instruments can be used without removing them from the case, and there is space for a small survey notebook as well. The 4 ounce case costs $11.95. (IMO, 102 Travis Circle, Seaford VA 23696. 804-898- 2809)



1987 NSS Cartographic Salon Entries

Chair: Bill Nelson

Compiled by John Ganter

Arizona		
Copper Chief Spring Cave	Yavapai Co.	Anonymous
BELIZE		
Gibnut Cave		Carol Vesely (MT)
California		
Millerton Lake Upper Cave	Fresno Co.	Carol Vesely
Mitchell Caverns	San Bern. Co.	Bob Richards (MT)
Pappy's Pt. Sea Caves	San Bern. Co.	Carol Vesely (HM)
Indiana		
Handprint Pit Cave	Laurence Co.	Keith Dunlap
JAMAICA		
Bona Fide Cave	Cornwall Co.	Mike DiTonto
Falling Cave	St. Eliz. Par.	Mike DiTonto
Welsch Ratbat/ Penthouse Cave	St. Eliz. Par.	Mike DiTonto
Kentucky		
Lost River Cave Group	Bowling Green	Chris Groves (MT)***
Livingston Cave	Bowling Green	Chris Groves
MEXICO		
Cueva de San Pedro	S. Luis Potosi	Carol Vesely (HM)
Missouri		
Boundary Pit	Pulaski Co.	Mick Sutton
Falling Spring	Oregon Co.	Mick Sutton (HM)
Secesh Cave	Carter Co.	Mick Sutton
Wind Cave	Shannon Co.	Scott House, M. Sutton (HM)
New Mexico		
Burro Cave	Debaca Co.	Dave Belski
Coachwhip Cave	Debaca Co.	Dave Belski
Crystal Caverns	Debaca Co.	Dave Belski
Pennsylvania		
Coral Caverns	Bedford Co.	John Ganter (MT)
South Dakota		
Black Hills Caverns		Mike Hanson
West Virginia		
Buckeye Creek Cave System	Greenbrier Co.	George Dasher (MEDAL)

Survey & Cartography Section of the
National Speleological Society

John Ganter
Department of Geography
302 Walker Building
The Pennsylvania State University
University Park, PA 16802 USA

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Cart Salon... cont

Friars Hole Cave System (8 maps)	Greenbrier/ Pocahontas Co.	Bob Gulden
Seneca Caverns (4 caves)	Pendleton Co.	John Ganter (MT)
Role Wonder Cave	Monroe Co.	George Dasher

MEDAL = Overal Winner
MT = Merit Award
HM = Honorable Mention

*** Special Class: Small-scale map of cave and terrain

Judges: Ernst Kastning, Bob Amundson.

GeoScience Resources

GeoScience Resources offers a selection of hard-to-find books, maps, charts and equipment. Of particular interest are geological highway, national park, and foreign country maps. Prices are not cheap, but compared to the hassle of trying to buy some of these items straight from the source.... 2990 Anthony Rd., Burlington, NC 27215. Orders: 1-800-PHACOPS. Color catalog on request.

Tektronics 3-D Workstation

At trade shows this past spring your editor was accosted by DNA molecules, space shuttles, and other scary things seeming to leap from computer workstations. Unlike previous machines, the new Tek 4126 only requires viewers to wear a lightweight pair of what appear to be ordinary glasses . The 4126 alternately flashes two images --one for the right eye, one for the left-- 115 times per second. Simultaneously, a liquid crystal shutter polarizes the light for each image so that it matches the filters on the viewer's glasses. Result: The left and right eyes sense what they are supposed to sense, and the brain contructs a 3-D view. Aimed primarily at CAD/CAM markets, the 4129 requires a supermicro-or-up host computer, and has a fairly hefty price tag. Even so, perhaps we'll see some caves rotating in three-space soon...