COMPASS & TAPE

Volume 2 Number 1

SUMMER 1984

COMPASS & TAPE

Editor and Publisher: John Ganter

Volume 2 Number 1 SUMMER 1984

Compass & Tape is the quarterly newsletter of the Survey and Cartography Section of the National Speleological Society. Dues are $4.00 per year and include 4 issues. When paying dues, please give your NSS number and make checks payable to the NSS Survey and Cartography Section. Subscriptions for cavers who are not NSS members, grottos, etc. are also $4.00 per year. The dues year begins at the annual NSS Convention. Those subscribing or joining late will recieve all back issues for the year. Material appearing in Compass & Tape may be reprinted provided credit is given and a copy of the publication is sent to the Editor. Opinions expressed in Compass & Tape are those of the authors and don't necessarily reflect those of the Section or Editor.

SURVEY & CARTOGRAPHY SECTION (1984-1985)

Chairman: John Ganter Vice-chairman: Paul Hill
Secretary: George Dasher Treasurer: Ray Keeler

Submissions and General Communications

Please send articles, maps, letters, comments, dues, address changes, etc. to: John Ganter
RD 3 Box 742
Bedford, PA 15522
814-356-3553

COVER: pen and ink by Ray Keeler.

CONTENTS

Compass & Tape is printed on a high-speed Xerox 9500 photocopier at the Penn State AE Copy Center, State College, Pennsylvania.

COMPASS & TAPE

Volume 2 Number 1 Summer 1984

KWIK TAPE

by Bill Torode

There was an article published in the April, 1983 MICHIANA CAVER about a new electronic measuring device called "Kwik Tape." This instrument sends out a signal which bounces back to the unit and gives a digital readout in feet and tenths of feet. It can measure distances between 3 and 99 feet. I realized that this unit could not be used to measure survey shots, but that it might be able to give ceiling heights, especially in rooms. In most areas of Alabama the limestone is fairly horizontal, which tends to give our caves flat ceilings.

On March 22 I headed for Hughes Cave (across the river in Morgan County), with John Hains, an engineer from American Data, where I work. The front part of Hughes Cave consists of a large room with some flat ceiling; but not, as it turned out, as much as I remembered. I had tried the unit at work, and had checked the distances with a tape measure, so I knew it was working right. In the cave we started out with some ceilings about 10 feet high. This short distance allowed us to aim for nice flat areas. We had to move the unit so that it was perpendicular to the ceiling, and then we got readings that were the same. We got good readings on ceilings that were about 10 feet high; above that we could not get consistent readings. It got very discouraging very quickly. We could not see the higher ceilings as clearly (even with electric lights), but the limestone surface appeared rough with cracks and holes.

Back at work the next day I again tested the unit outside against the side of the building in ten foot increments. It worked perfectly up to 96 feet. I would have to say that this unit requires flat, man-made surfaces; this obviously kills it for cave work. I sent the unit back to the manufacturer with a note mentioning my particular application, and that I would be very interested in a two-piece unit that would measure distances to the hundredths of a foot between them. It does not seem that this would be difficult to accomplish. So far no word from the manufacturer, including no refund. I would not recommend this unit for cave work, but it appears to work well otherwise.

Keep Kave Mapping, /s/Bill Torode

FEEL LIKE YOU'RE MISSING SOMETHING??

Volume I of Compass & Tape is still available from the Editor for $4.00

COMPASS & TAPE

Volume 2 Number 1 Summer 1984

SUUNTO SURGERY

by John Ganter

One day last winter I was out starting a cave survey when I noticed with dismay that my Suunto clinometer was sticking! Instead of showing the usual smoothly damped motion, it just stayed there. My companion confirmed this with half-hidden glee, since he just wanted to blow up sinkholes anyway. No problem, I thought, I will simply perform surgery to readjust the pressure on this ailing instrument's internals.

My brilliant plan was to drill a small hole in the clinometer capsule, adjust the bearing by reaching through the hole with a jeweler's screwdriver, then reseal the hole with silicone or epoxy. Unfortunately, my plan went awry when I discovered that the adjustment screw is sealed with an anaerobic locking agent to prevent it from turning! My patient was dead. So, being a good scientist, I performed an autopsy. If you're not squeamish, have a look:

These are the parts that are removable from the aluminum case. Clockwise from left; O-ring which seals canister to aluminum case. Top of canister, which was cut in half with a hacksaw. Dial holder. Dial, notice weight cemented at upper right. Tension rings, these hold the canister pressed tightly against the O-ring. Aluminum back cover, with drilled hole which allowed it to be pried off. Note that only half of the plastic canister is shown.

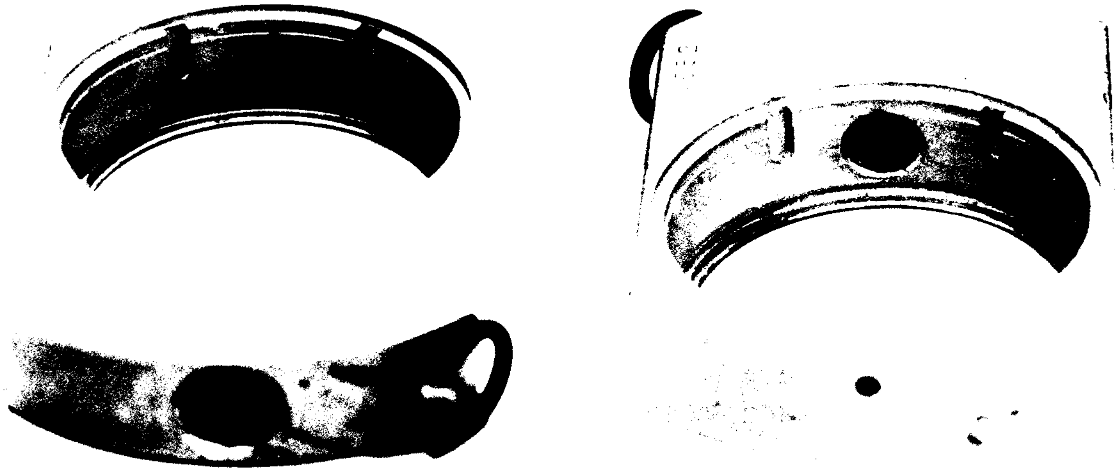
Above, you can see a detail view of the clinometer dial and its holder. (The dial would actually be flipped over to fit into the holder as it is shown.) There is a similar needle bearing on the front of the dial. The pressure on these bearings is adjusted at the factory, then the adjustment screw is locked in place with a chemical agent.

So why did my clinometer cease to operate? I found that the plastic canister, which surrounds the dial holder,was deformed. I had tried to dry out the inside of the compass too quickly and overheated it. The dial holder is made of very thin aluminum; the slightest deformation of the plastic canister will bend it and cause the dial to stick. Anyway, I sent the body off to Forestry Suppliers and had them rebuild it. It came back with a new canister and viewing lens- essentially as good as new.

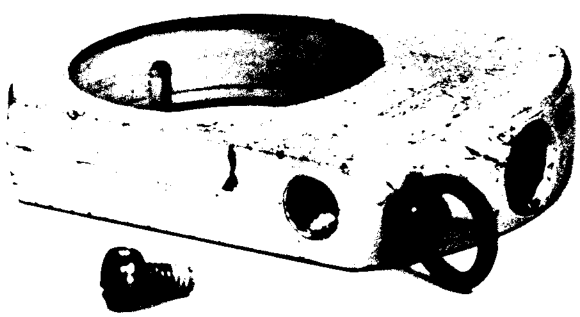
But my misfortune was not over. A few months later my compass got sticky! I havn't done a full autopsy, but I assume that it's a similar problem, although I've been careful to keep the instruments away from heat since the first incident.

Clockwise from top
O-ring. Compass Body. Back plate, with hole drilled for prying off. Brass pressure ring. Compass canister.

Below left: looking towards the front of the compass body. Twin grooves lock canister in place. Set screw between them evidently keeps canister from sliding out. Below right: looking towards back of compass body. Two more locating grooves are visible. Between them is viewing tube. When the canister is in place , a clear area in its circumference, with the sighting line molded in, serves as the window to view the floating dial. There is no seal where this window fits up against the end of the viewing tube, so if water and dirt get past the O-ring (which would be below the tube in the photo) or the back cover (above the tube in the photo), it can easily foul the tube and the viewing lens at its opposite end.



One way to modify the existing compass to allow easier removal of dirt and water is installing flush ports. Shown <u>below</u> is Art Pettit's design. A hole is drilled all the way through the body, then each end is threaded and countersunk to form a groove in which a small O-ring can seat. The O-ring is slipped over a non-ferrous stainless steel machine screw. When the plugs are installed, they are flush with the compass body. The clinometer design is identical. Two other designs I've seen use plastic or brass plugs which are not flush.



For more on Suunto instruments see "How to Use The Suunto" by George Veni and "The Wet Suunto: A Treatise On the Care and Feeding Of Abused Cave Survey Instruments" by Roberta Swicegood, both in Vol. 1, No. 1 (Summer 1983) COMPASS & TAPE.

PAPER SESSION: NSS Convention 1984

by Paul A. Hill

The 1984 Convention of the NSS was a great success for the Survey and Cartography Section.

The papers session attracted more than 50 people and featured four very good papers. I organized the session this year and got several "volunteers". I just happened to be talking to them long-distance when they volunteered, but that is another story.

The first paper was an interesting presentation by Bob Hoke entitled "An Analysis of Instrument Reading Errors." This was a look at what is perhaps the largest collection of instrument readings ever taken by cavers under controlled conditions. Bob claimed not to be a statistician, but still had some interesting things to say including several suggested modifications to Suunto instruments to help eliminate blunders.

The second paper was by George Dasher, the new 1984-85 secretary of the Section, and covered some of the more practical problems of organizing a survey project. George had lots of good suggestions and hints about keeping a project going and producing a final map.

If you think that you have a tricky cave to draw, you should have attended the third paper, which was given by Charles Clarke. Charles talked about the fun that he and Jeff Sims have had trying to finish a final map of Xanadu Cave. Jeff had lots of photos of parts of the cave, including areas with lots of small passages (hard to show on a small-scale map) and other areas with multiple levels shown in different colors. This was a good paper on the problems that can arise in drawing a map of a large cave.

The final paper was a step beyond the large cave. Stephen Attaway's paper dealt with state cave surveys. In particular, it focussed on his attempt to to catolog and computerize all caves in the TAG (Tennessee, Alabama, Georgia) area. This is no small project, to say the least. Stephen has produced plots of caves including digitized passage shapes suitable for overlaying on 7.5 minute topo quads, and has also produced small scale state maps showing the locations of entrances. (This map was one of two computer-generated maps entered in the Map Salon.) Anyone who is interested in the problems of projecting cave locations on 7.5 minute topo maps or smaller scale maps should definitely get a copy of Stephen's paper entitled "Projection Techniques and Map Construction."

CAVE SKETCHING

by Keith Ortiz

Cave survey sketching means many things to many people. In multi-level cave systems, the sketch may be the only record of the lower passages' detail; upper passages obliterate the lower in most final maps. Also, the sketch is usually drawn at a scale much larger (more detailed) than the final map. In summary, someone truly interested in passage development must use the sketches.

There is some controversy concerning the amount of detail that should be shown on a sketch. In a project cave, involving various groups of surveyors, the notes can become widely disseminated , even public knowledge. I personally will not note formations or other "endangered" artifacts on a cave sketch unless they are significant in altering passage characteristics, e.g. flowstone chokes. Then, again, some detail which I add to my sketches would be considered useless or excessive by others.

The tactic we've taken in a central Kentucky survey project is that the survey notes should at least show details that are prevalent in other caves in the region. In our case, there is sufficient coverage in various publications to give an idea of what we can expect to encounter on a survey.

After making a list of features which are considered relevent, a check-list of do's and don'ts was made and incorporated into a standard survey notebook. This standard book is required for use on trips to this project.

In addition to customary survey practices, such as placing a station at every side lead, the book also contains a sketch page with "promptors" to guide the sketcher. An example (see Figure A), with the page marked off at 5 degree intervals, is shown.

When the north arrow is set, it's a simple matter to mark off the headings necessary, considering the passage being traversed. The scale and north arrow are also prompted. The two arrows at the bottom of the page are for flows which we consider extremely important in the survey. They are reminders to the sketcher to note air and paleo flow directions in all passages.

One thing which we tried for awhile was having a seperate page to catalog leads. As you can see in Figure B, this also contained space for recording other vital information about the surveyors and the equipment used. This system did not work well, so we have returned to recording this data on the main survey sheets.

Although it's impossible to make a complete list of cave features which will be encountered, a properly designed survey book can coax more observations out of the survey team. Surveyors will at least be on the alert for features they've read about and there will be no questions afterward about divergent survey practices. Cavers unfamiliar with the cave will know what to expect. In this manner, a more uniform and detailed series of survey notes can be collected with a minimum of duplicated effort.

(Reprinted from the D.C. SPELEOGRAPH, June, 1981.)

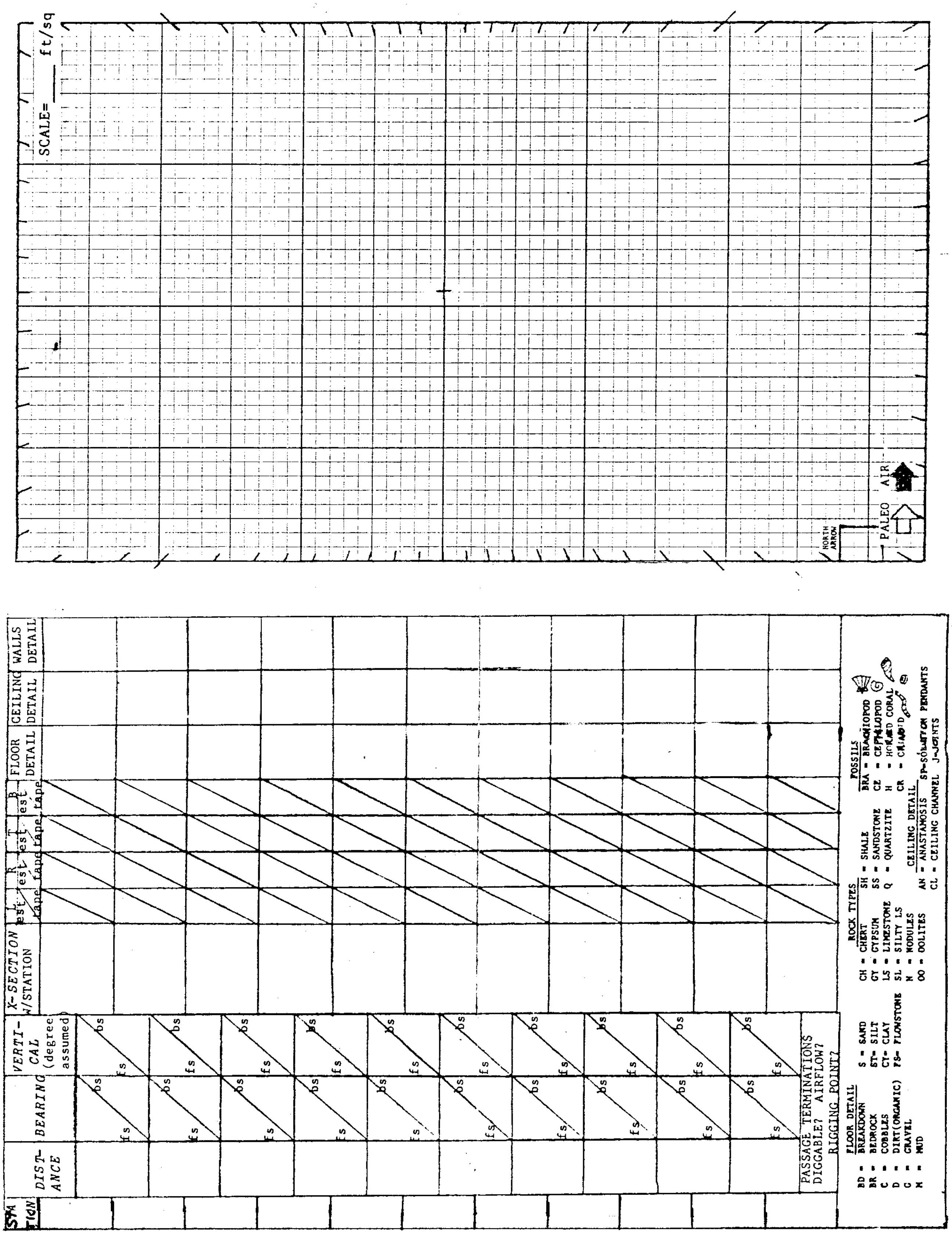


FIGURE A: Fisher Ridge survey page. Original is indeliably printed on one side of a piece of polyester drafting film. Same size as original.

NAME/PLACE OF SURVEY: ________

DATE IN: ________

NOTES: ________

TAPE: ________

INST. F/S: ________

B/S: ________

EXPLORATION ________

OTHER ________

TAPE: (10ths/INCES, FEET/METERS

ADDRESSES AND PHONE NUMBERS OF ANY NEWCOMERS MUST BE SHOWN !!

COMPASS

	TYPE	OWNER	DECL.
F/S			
B/S			

CLINOMETER

F/S			
B/S			

STATION	SIDE LEAD DESCRIPTIONS (trends, H x W, potential)

etc.

Figure B: Supplemental Data Sheet. Printed on the back is a stratigraphic section for the Fisher Ridge area and a table of sines and cosines for estimating horizontal and vertical distances.

WANTED: CAVE SURVEYERS AND CARTOGRAPHERS

Volunteer cave mappers are needed to assist with cave research projects in Bermuda and other locations such as the Turks and Caicos Islands, Canary Islands, etc. Work includes cave surveying, writing of computer programs to process the survey data, drafting of finished maps, producing overland surveys of small but highly karstified areas, and teaching of surveying techniques to local cavers. Projects or trips will be about 1-2 weeks in length. For more information, send a letter describing your skills, a copy of a map you have done, and your availability to:

Dr. Tom Iliffe
Bermuda Biological Station
Ferry Reach 1-15
Bermuda

COMPASS & TAPE

Volume 2 Number 1 Summer 1984

The Effect Of Tilt On Compass Error

by Lang Brod

Many cavers don't realize it, but even small off-level tilts can cause significant compass errors. Figure A shows a bubble level installed in a Suunto compass, which will greatly reduce this error. Also shown is a glass rod which can assist the instrument reader in making readings to targets which are at a steep angle above or below the instrument. The derivation of my error formula is discussed below.

The magnitude of the error can be determined by trigonometric analysis, as shown in Figure B. In this figure, the triangle A-B-C is in a vertical plane defined by station line A-B, while triangle A-C-D is in a horizontal plane drawn through the sighting station A. The line A-C lying directly below the station line A-B is the true azimuth. For the sake of argument, assume the compass is initially levelled with the vertical slit in it's front sight parallel toB-C. If the compass is tilted slightly , using the station line A-B as an axis, the front sight will align itself parallel with B-C'. The front of the compass will tilt upward slightly. For convenience, assume that the front of the compass is tilted downward to compensate this upward tilt, so that the compass is tilted only in a plane perpendicular to the compass axis. Under these conditions, the compass axis will lie along an erroneous azimuth, line A-D, which deviates from the true azimuth by an angle e. The resulting configuration can be analyzed by the use of trigonometry:

In the figure (B):
- i = angle of inclination to target
- t = angle of tilt of compass
- e = angular compass error

$$h = L \tan i \quad \text{and} \quad S = h \tan t$$

combining,

$$S = (L \tan i)(\tan t) \qquad \text{but,} \quad \tan e = \frac{S}{L} = \frac{(L \tan i)(\tan t)}{L}$$

$$\text{thus,} \quad \tan e = (\tan i)(\tan t)$$

The derivation of this error formula is based on certain initial assumptions. A different set of assumptions might possibly lead to a slightly different result, but my derivation produces a mathematically simple result which can be readily calculated. The results of this calculation are summarized in Figure C.

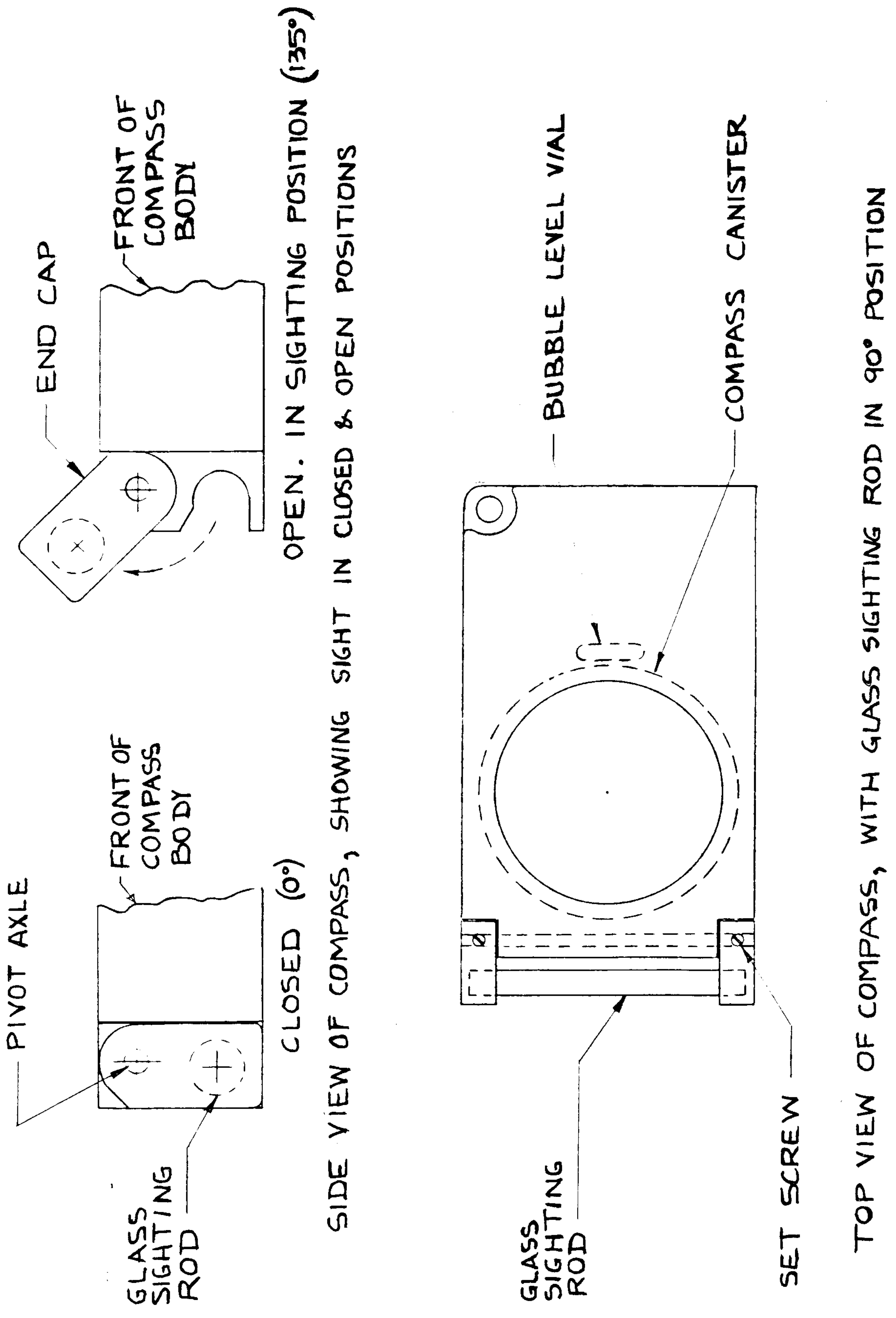

END CAP
FRONT OF COMPASS BODY
OPEN. IN SIGHTING POSITION (135°)
PIVOT AXLE
FRONT OF COMPASS BODY
CLOSED (0°)
GLASS SIGHTING ROD
SIDE VIEW OF COMPASS, SHOWING SIGHT IN CLOSED & OPEN POSITIONS
BUBBLE LEVEL VIAL
COMPASS CANISTER
GLASS SIGHTING ROD
SET SCREW
TOP VIEW OF COMPASS, WITH GLASS SIGHTING ROD IN 90° POSITION

Figure A

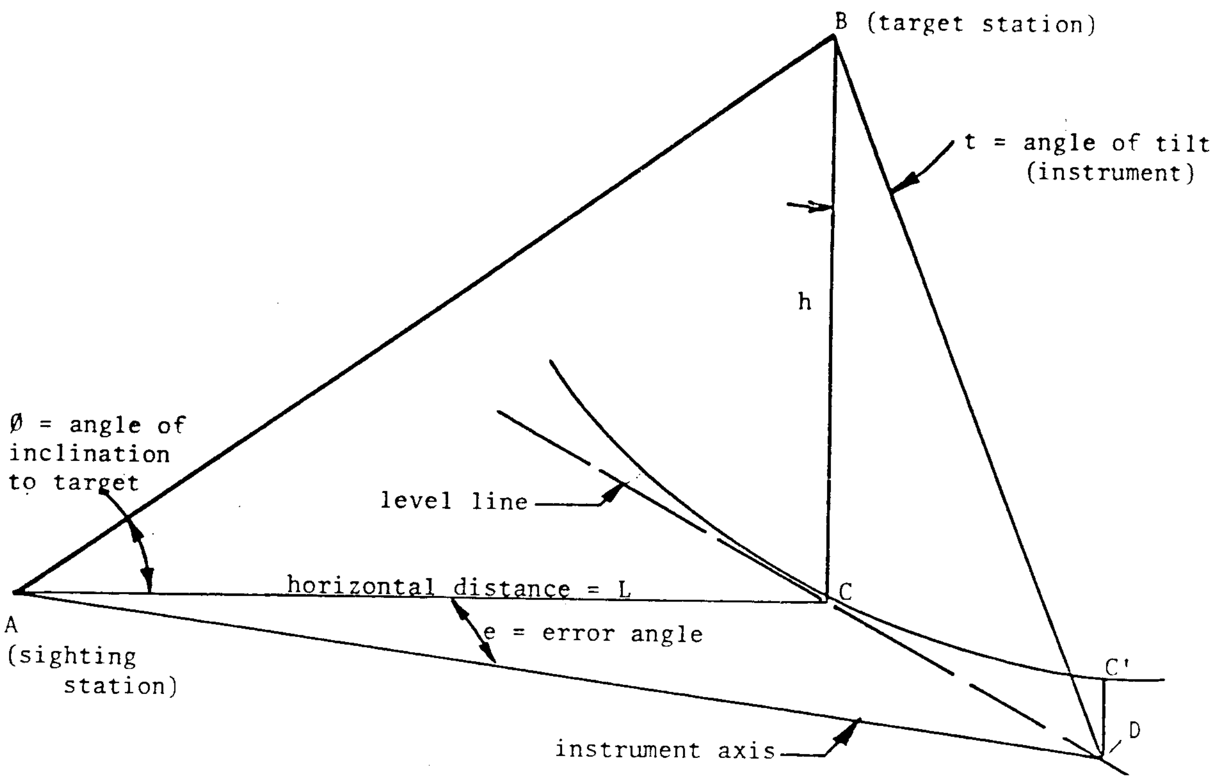


Figure B Geometry of the Tilted Compass

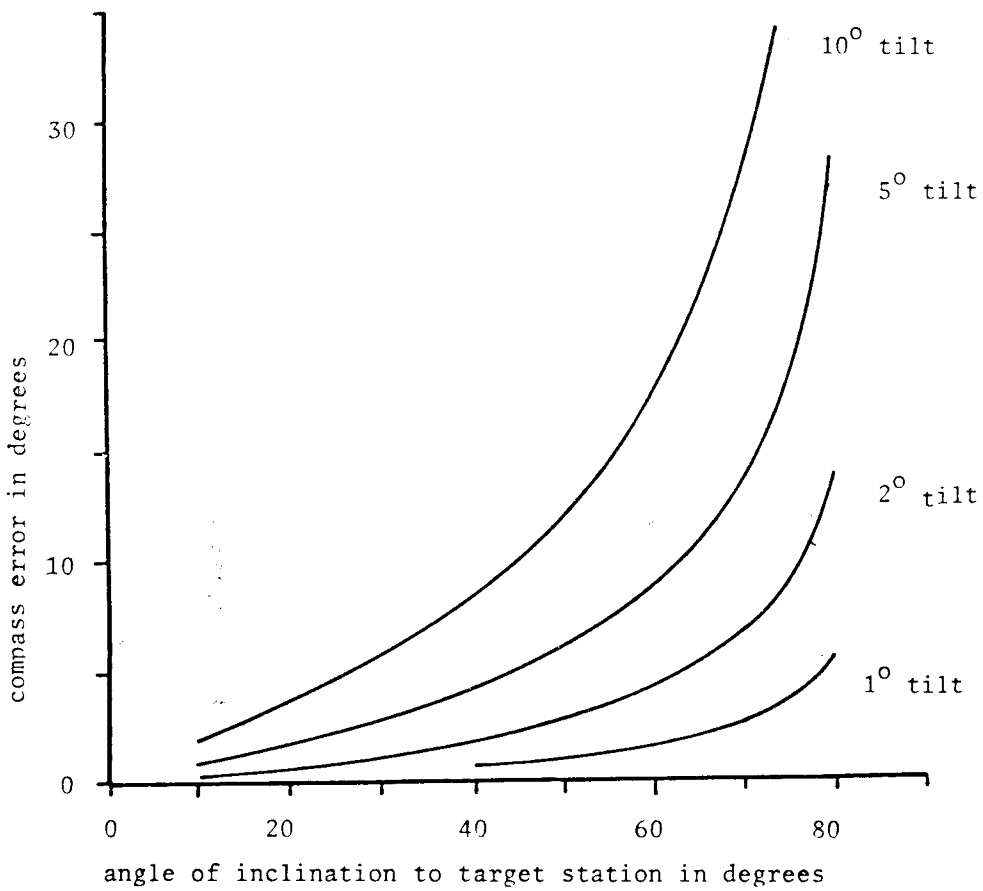


Figure C Error in the Tilted Compass

Volume 2 Number 1 Summer 1984

SOURCES OF ERROR IN CAVE SURVEYS

PART 1: TYPES OF ERROR

by Dan Crowl

In 1974 I published a series of articles in the Mid-Illinois Grotto Newsletter related to cave survey errors. Since these articles were published, Crump's Spring Cave has been replaced by Fisher Ridge Cave, and a number of new individuals have replaced the old ones. Thus, I have reorganized the material, added some new stuff, and am now presenting it in the new DUG SCOOPS. I will dwell mostly on concepts, but some math and algebra will be required to justify some of the concepts.

My experience is that cavers know little about terms such as precision, accuracy, discrepancy and error. In general, they tend to use these terms almost synonomously. In reality, all of these terms mean different things.

The surveyor must realize that no survey can be exact and some error is always introduced. It is the surveyors job to be familiar with these sources and types of error and how they affect survey accuracy.

PRECISION AND ACCURACY

Precision refers to the degree of refinement in the performance of an operation, while accuracy is the degree of conformity to a standard. Precision, therefore, relates to the quality of execution, while accuracy relates to the quality of the results. For instance, one can usually read a Suunto compass to within a half degree during a cave survey. This is a reflection of instrument precision. However, the compass could be defective and be completely biased by 5 degrees even though it could still be read to the same half degree precision. (Backsights, of course, would reveal the 5 degree problem.) The 5 degree bias would affect the accuracy of the resulting survey.

Our main objective is survey accuracy. In order to achieve this accuracy, we require a certain amount of instrument precision. A survey performed with only a single compass reading at each station reflects mainly on the instrument precision. A survey performed with foresights and backsights at each station reflects survey accuracy. In general, the accuracy of the survey is less than the instrument precision. Thus, while we can read the Suunto compass to within a half degree, our backsights and foresights are only within a 2 degree margin.

SOURCES OF ERROR

The following definitions apply to errors rather than mistakes. Mistakes, being quite distinct from error, are due to poor judgement, confusion or just downright incompetence on the part of the surveyor. Since mistakes are due to a failure to execute the survey properly, they will not be covered in this series of articles.

INSTRUMENTAL ERRORS: Instrumental errors arise due to imperfections in the instrument used to measure the desired quantity. For instance, the graduations on a compass might be off slightly from their "true" positions. Or, atape may be unnoticably stretched beyond its correct length. Since cave surveys are usually of low order accuracy(a few percent) the instrumental errors are generally negligable.

PERSONAL ERRORS: Personal errors are due to limitations in the human senses, mainly sight and touch. For example, no matter how much one practices reading a hand-held compass, the compass can only be held so steady and "eyed-in" to a certain extent. Due to the normal physical abuse experienced by cavers, these types of errors occur frequently and are a major contributor to survey error. Experience and practice can usually overcome these difficulties.

NATURAL OR ENVIRONMENTAL ERRORS: This source of error is due to changes in temperature, humidity, magnetic nature of the surrounding rock, etc. It only includes factors which affect the instruments themselves. It does not include harsh environmental conditions (e.g. water crawls) that lead to personal errors by the surveyors. This source of error is of no concern to the cave surveyor, at least usually. However, I have heard of cavers invoking"magnetcic ore deposits" to account for difficulty in achieving foresight and backsight agreement. Magnetic ore is not known to be found in limestone.

TYPES OF ERROR

No matter what the source of error, it can be classified as to type.

SYSTEMATIC ERRORS: Systematic errors result when an error of the same origin is applied to successive readings. A classic example of this type of error would occur if the first few feet of the survey tape was lost. A systematic error equal to the lost distance would be introduced with each tape measurement. Errors of this type tend to accumulate and can lead to enormous accumulated errors. Fortunately, systematic errors can always be reduced by taking proper precautions to eliminate them.

ACCIDENTAL ERRORS: Accidental errors are beyond the control or detection of the surveyor. For example, the reading accuracy of the compass or tape introduces accidental errors. Errors of this type tend to be compensating; that is, the algebraic sign of the error is due to chance and can be either positive or negative. Accidental errors are also called random errors, irregular errors or erratic errors. Errors of this type can be predicted or determined with a reasonable amount of accuracy. This subject will be considered in future articles.

In addition to the above absolute terms, there are also a number of expressions that refer to comparative errors.

DISCREPANCY: Discrepancy refers to the difference between two values for the same quantity; either between a measured value and a known value, or two measured values. In cave survey work, discrepancies are most apparent when an attempt is made to close a surveyed loop. Discrepancy, however, reflects only the magnitude of the accidental error. Systematic error are not included. For instance, in two measurements of the same 100 foot survey shot, a discrepancy of only 1 foot might be shown, but systematic errors of 5 feet might be common to both.

RESULTANT ERROR: This is a difference between the measured value of a quantity and the true value. Since the true value can never really be dtermined, it is never really possible to determine the resultant error.

RESIDUAL ERROR: This is the difference between the value of a single measurement of a quantity and the mean value of a quantity obtained by numerous measurements. The residual error most nearly approximates the resultant error since the true value of a quantity is approached as the number of measurements increases. The residual error for a cave survey can be dtermined by careful analysis of the survey loop closures.

As you can plainly see, the analysis of cave survey errors is a complicated subject! I hope that I ahve provided some insight into this subject for all cave survey people (and others, too, perhaps!)

PART 2: LOOPS AND LOOP CLOSURES

In this article, I will demonstrate how cavers incorrectly use loop closure errors as an indication of survey accuracy. I will show that, if the loop closure error is large, then this is an indication that a blunder has probably occurred. However, if the loop closure error is small, then nothing can be said about overall survey accuracy.

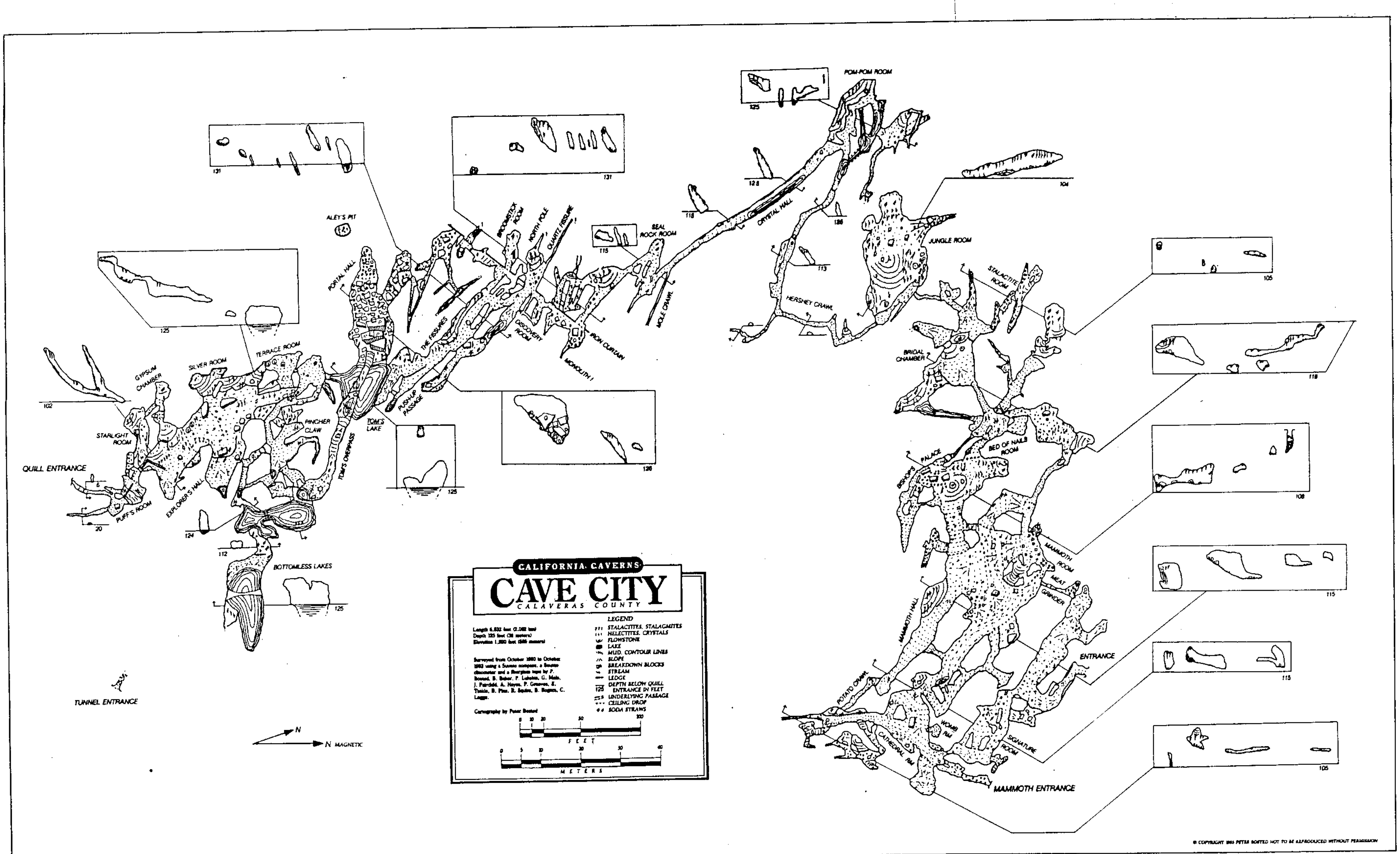
Consider a survey between points A and B in a cave.Suppose I survey between these two points using two separate paths. Since both surveys started and ended at the same physical points, I would expect (in an ideal world) the final ending point (B) to exactly coincide for both surveys. In reality this does not occur and one finds that point B plotted using the different surveys is not the same. The absolute distance between the two point B's is called the loop closure error and is the result of the accumulated errors throughout the survey segments. A relative loop closure error can be defined as the loop closure error divided by the total distance in the loop.

If both surveys plot to different point B's, then where is the"real"point B ? In reality, we don't know, because we live in a world where nothing can be measured exactly. However, we could make a number of resurveys of both loop segments and plot all of the point B's that result. The point B's plotted would soon blacken an area at the end of the survey segments. We can then say that there is an increased probability that the "real" B is within this area. As the number of surveys increases, so does the probability. In the limit, the probability is 100% that the "real" B is within the area when the number of surveys is infinite.

A more attractive alternative to improving our estimate of point B's location would be to perform a survey of greater accuracy. This could be accomplished by using instruments of much greater precision. In this case, we would still find a loop closure error; however, it would be smaller and we would also define a much smaller earea by plotting the results of a number of resurveys.

Let's return to the question of interpreting the results of a loop closure. As I indicated earlier, cavers frequently imply that that a good loop closure means an accurate overall survey. This is simply not the case. In reality, it is only an indication of the survey accuracy at that particular point in the survey. The accuracy at any other point in the loop or survey can be larger or smaller than the loop closure. This statement can be proved rigorously by using the triangle inequality in mathematics. For this article, I will "prove" it by using a simple example that I call the rectangle survey.

Consider a rectangular survey with just 4 survey shots. Each shot is at right angles to the adjoining shot. The first shot is due north and the real distance is 10 feet. Unfortunately, the tape was read as 15 feet, an error of +5 feet north. The second survey shot is due east, and was read correctly as 10 feet. The third shot is due south. This time the distance is read as 15 feet, when it should have been 10 feet, an error of -5 feet due north. Let's plot the actual distances using a solid line and the surveyed distances using a dashed line. The results of our plot indicates that both surveys close exactly, even though we know that the dashed line survey has grave errors.

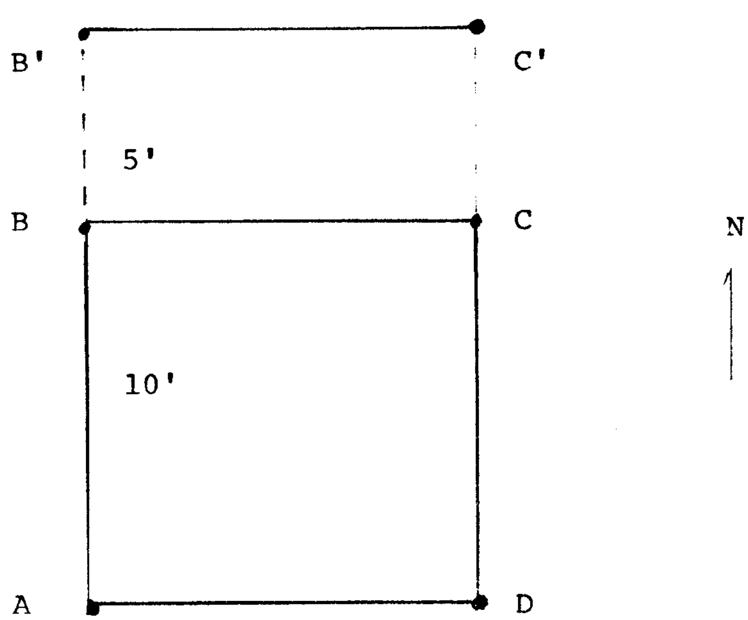

CALIFORNIA CAVERNS
CAVE CITY
CALAVERAS COUNTY
LEGEND
STALACTITES, STALAGMITES
HELECTITES, CRYSTALS
FLOWSTONE
LAKE
MUD, CONTOUR LINES
SLOPE
BREAKDOWN BLOCKS
STREAM
LEDGE
125 DEPTH BELOW QUILL ENTRANCE IN FEET
UNDERLYING PASSAGE
CEILING DROP
SODA STRAWS
0 10 20 50 100
FEET
0 5 10 20 30 40
METERS
QUILL ENTRANCE
TUNNEL ENTRANCE
MAMMOTH ENTRANCE
ENTRANCE
POM-POM ROOM
CRYSTAL HALL
JUNGLE ROOM
HERSHEY CRAWL
STALACTITE ROOM
BRIDAL CHAMBER
BED OF NAILS ROOM
PALACE
MAMMOTH ROOM
MEAT GRINDER
MAMMOTH HALL
POTATO CRAWL
CATHEDRAL RM
WOMB RM
SIGNATURE ROOM
SEAL ROCK ROOM
MOLE CRAWL
IRON CURTAIN
MONOLITH I
DISCOVERY ROOM
QUARTZ FISSURE
NORTH POLE
BROOMSTICK ROOM
THE FISSURES
PUSHUP PASSAGE
TOM'S LAKE
TOM'S OVERPASS
PORTAL HALL
ALEY'S PIT
PINCHER CLAW
TERRACE ROOM
SILVER ROOM
GYPSUM CHAMBER
STARLIGHT ROOM
PUFF'S ROOM
EXPLORER'S HALL
BOTTOMLESS LAKES
N
N MAGNETIC

This brings us to the concept of compensating errors. Since random errors can be in any direction, some of the errors may be due north and some might be due south (as in the example). These errors and others that occur at opposite ends of the survey compass will tend to compensate. This is why it is possible for the error at various stations throughout the loop to be larger than the ultimate loop closure, since this error could be reduced at the closure by random errors in compensating directions.

If this is the case, then what is the value of calculating loop closure errors? As I said earlier, if the loop closure error is inordinately large, then there is an excellent chance that a blunder has occurred somewhere in the survey string. This is the only value of loop closure error calculations. If the loop closure error is small, then, again, nothing can be said. In fact, it is conceivable (as in the example), that large, compensating errors were made in the survey. However, the chances of a particularly large blunder being compensated exactly by another large blunder, or a series of small blunders is fairly remote.

In the next article of this series, I will discuss the numerical treatment of loop closures. I will show that a difficulty exists here, because current procedures distribute the error throughout the distance, when, in reality, the errors should be distributed through the angles.

(Reprinted from the DUG SCOOPS, January, 1983 and August, 1983.)



CENTERFOLD: CALIFORNIA CAVERNS - CAVE CITY

by Peter Bosted. Recieved Honorable Mention in 1983 NSS Map Salon, 1-3 KM. category.

COMPASS & TAPE

Volume 2 Number 1 Summer 1984

Thoughts On Sealing Suuntos

by Lang Brod

The problem of sealing Suunto instruments against water entry is a complex one. One solution that I am currently considering is O-rings. The basic O-ring seal utilizes an annular groove machined in metal in which the O-ring sits. The depth of the groove is slightly less than the cross-sectional diameter of the O-ring and the inner diameter is equal to the inner diameter of the ring, while the outer diameter is slightly larger than the O-ring diameter to allow for expansion when the ring is compressed. (See Figure A.) Thus, the size of the groove is proportional to the cross sectional diameter of the O-ring; to minimize the size of the groove, it is necessary to use a ring with a small cross sectional diameter. The smallest conventional O-rings have a cross sectional diameter of .070 inch, requiring a groove about.052 inch deep by .090 inch wide, too large for use on a compass. What is required is an O-ring with a cross sectional diameter of about .020 inch, which would utilize a groove about .025 inch wide by about .015 inch deep.

Apple Rubber Products of Lancaster, New York manufactures a series of small O-rings. Unfortunately, their minimum order is &50.00, which will buy 100 each .394 I.D. by .022 inch thick O-rings To seal the lens) or 76 each .512 inch I.D. by .020 inch thick O-rings (to seal a window over the lens). Larger sizes, useful for sealing the the large window over the compass canister, are no longer in production, and a set of new dies for manufacturing them would be prohibitively expensive. It appears that the best solution for the large window is to use a thin sheet elastomer from which a gasket of suitable size can be cut.

It should be obvious that effective sealing of the compass will require a custom built compass case. I don't think that there is any way of sealing the supplied metal case. It would probably make more sense to purchase the cheaper plastic case compass and install the compass canister in a sealed custom metal case.

The small biconvex lens used in the compass can be readily sealed with a small O-ring, but the retaining ring used outside the lens would leave a small circular depression directly over the lens which would accumulate mud and water. What is required is a small sealed window which is planar and set flush with the compass body so that a single wipe will clean its surface. Inasmuch as the surface must be flush, it would be necessary to make the window in the form of a truncated cone or a rectangular window with tapered edges, as shown in Figure B. Fabrication of such a window would require diamond grinding tools. Consequently, the tradeoffs and ramifications of of the compass design must be very carefully considered. Rather than discussing these details at the present time, I would like to give the whole problem further study.

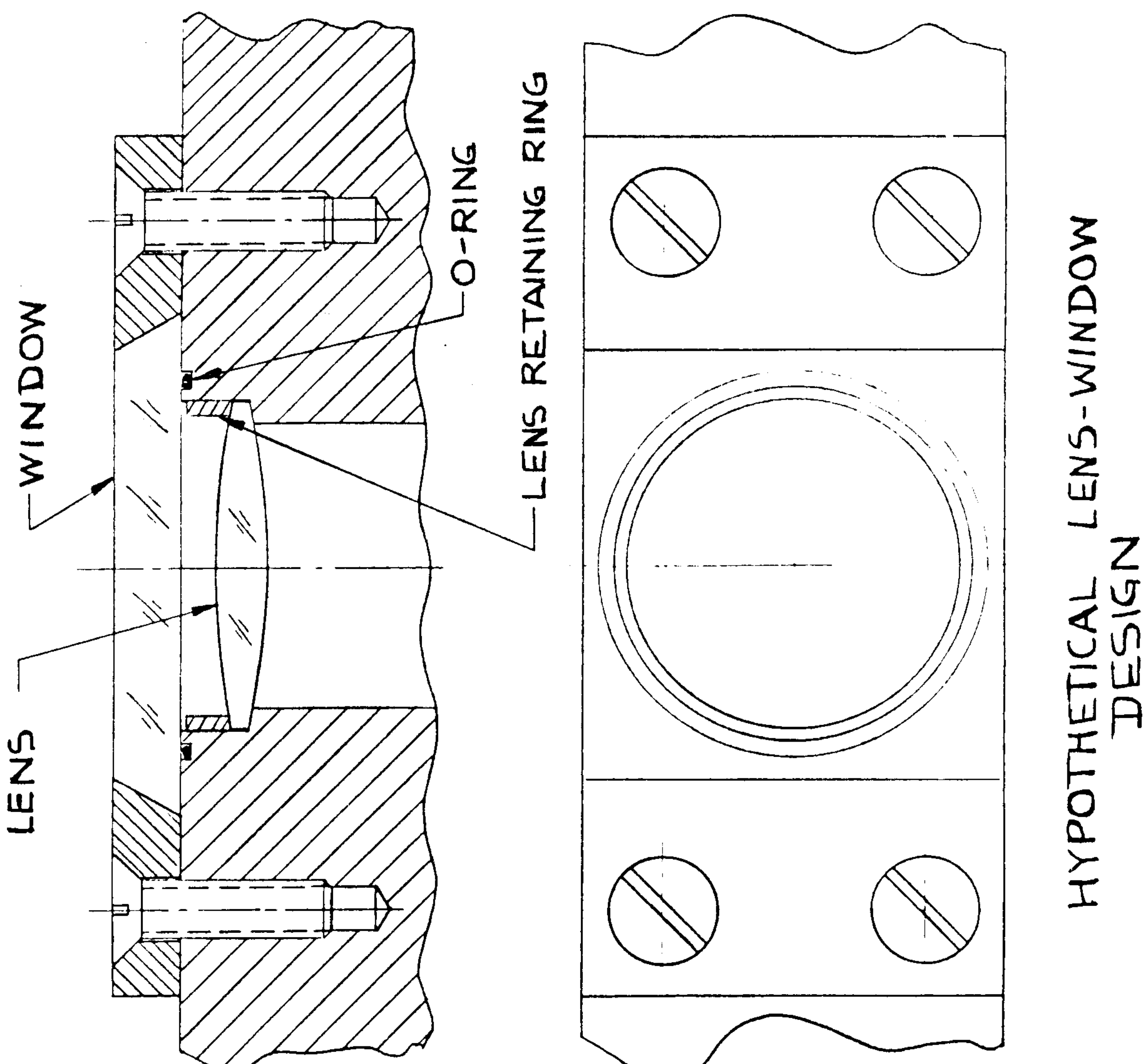


FIGURE B

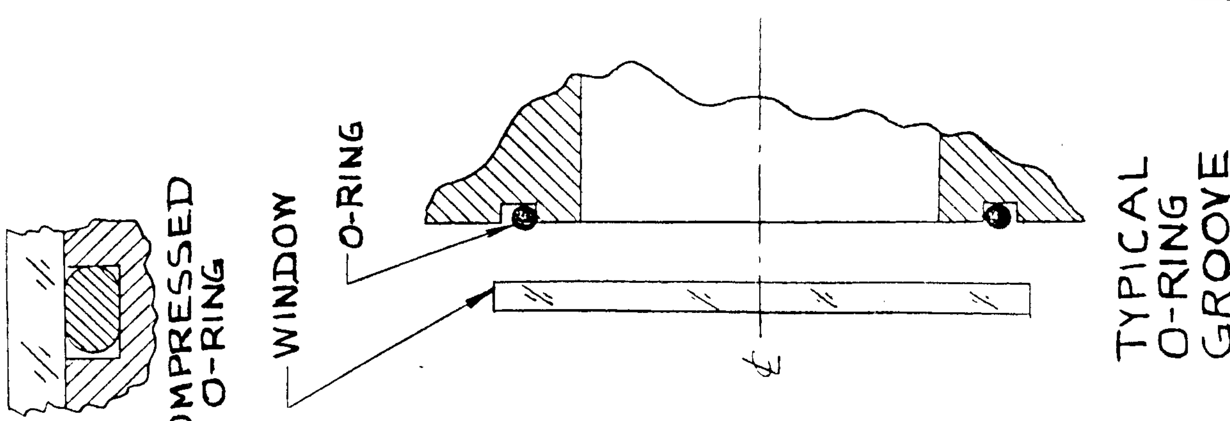


FIGURE A

COMPASS & TAPE
Newsletter of the NSS Survey & Cartography Section
John Ganter, Editor
RD 3 Box 742
Bedford, PA 15522

LIBRARY RATE
NONPROFIT SCIENTIFIC ORGANIZATION
Return Postage Guranteed
See Section 725.1 of Domestic Mail Manual.

SECTION MEETING: NSS Convention 1984

by Paul A. Hill

The Section meeting wasn't as exciting as last year's, but then we were in a classroom without pizza and beer this time. After a quick vote that decided we still need four officers, we held held elections. John Ganter was re-elected Chairman and Ray Keeler was re-elected as Treasurer. After it was decided that it should be the job of the Vice-Chairman to put together the paper session, I was re-elected Vice-Chairman. None of us were opposed in the election. To fill the place of Secretary after I was "promoted", George Dasher was nominated and elected.

The other big item of business was the discussion of a cave surveying book to be published by the NSS. The project was rekindled by Doug Medville and now has become a Section project. Ray Keeler has taken the job of coordinating the efforts. It is expected that between the members of the section we will be able to put together a small, up-to-date book covering beginning to advanced cave surveying. For more information on the book project or to volunteer your talents, even if you just want to be a reviewer, please contact Ray.