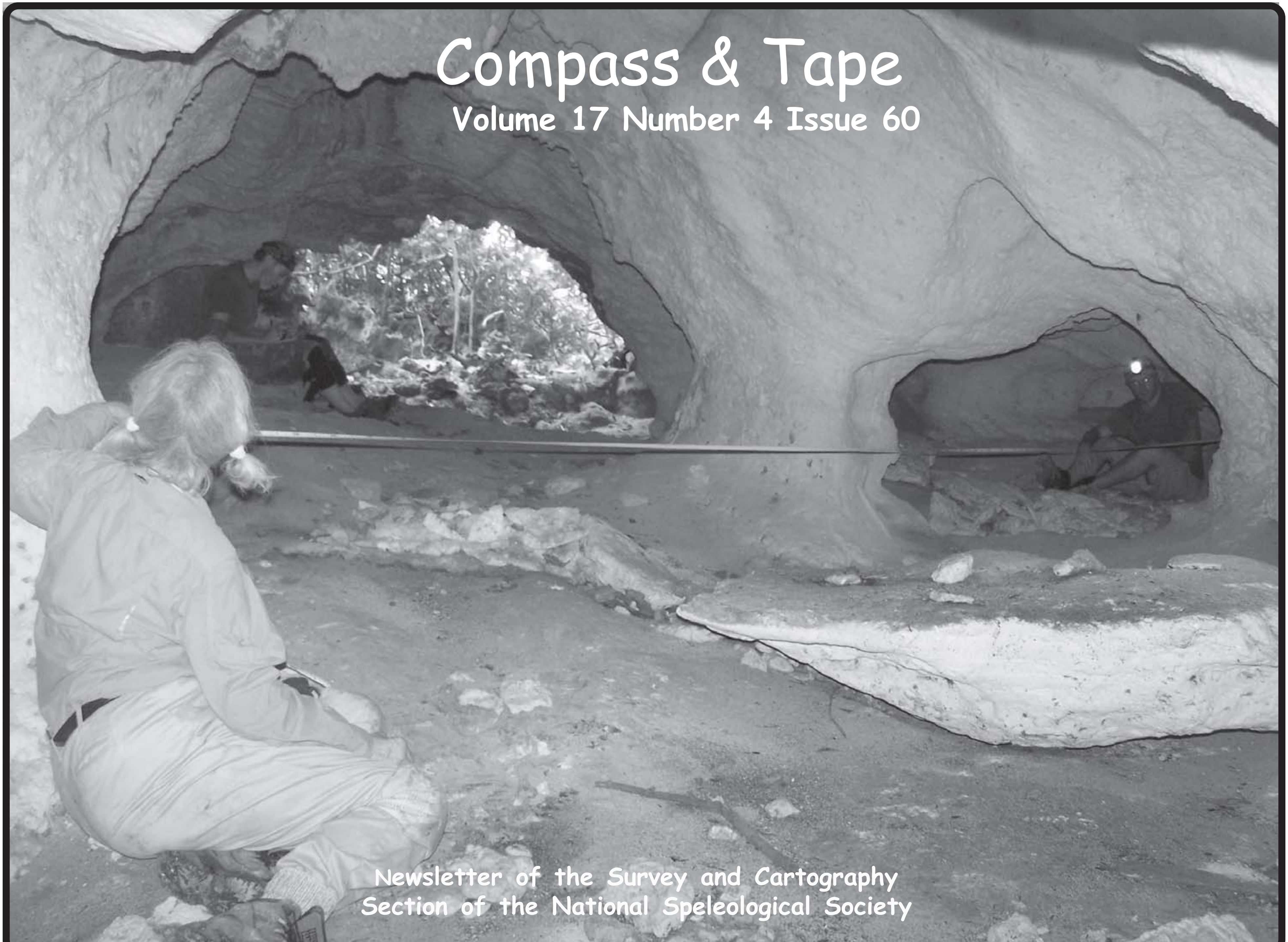
Compass & Tape

Volume 17 Number 4 Issue 60



Newsletter of the Survey and Cartography Section of the National Speleological Society

Survey and Cartography Section

The Survey and Cartography Section (SACS) is an internal organization of the NSS that is devoted to improving the state of cave documentation and survey, cave data archiving and management, and of all forms of cave cartography.

Membership: Membership in the Section is open to anyone who is interested in surveying and documenting caves, management and archiving of cave data and in all forms of cave cartography. Membership in the National Speleological Society is not required.

Dues: Dues are $4.00 per year and includes four issue of *Compass & Tape.* Four issues of the section publication are scheduled to be published annually. However, if there are fewer, then all memberships will be extended to ensure that four issues are received. Dues can be paid in advance for up to 3 years ($12.00). Checks should be made payable to *"SACS"* and sent to the Treasurer.

Compass & Tape: This is the Section's publication and is mailed to all members. It is scheduled to be published on a quarterly basis, but if insufficient material is available for an issue, the quarterly schedule may not be met. *Compass* & *Tape* includes articles covering a wide range of topics, including equipment reviews, techniques, computer processing, mapping standards, artistic techniques, all forms of cave cartography and publications of interest and appropriate material reprinted from national and international publications. It is one of the media for conveying information and ideas within the U.S. cave mapping community. All members are strongly encouraged to contribute material and to comment on published material. Items for publication should be submitted to the Editor.

NSS Convention Session: SACS sponsors a Survey and Cartography session at each NSS Convention. Papers are presented on a variety of topics of interest to the cave mapper and cartographer. Everyone is welcome and encouraged to present a paper at the convention. Contact the Vice Chair for additional information about presenting a paper.

Annual Section Meeting: The Section holds its only formal meeting each year at the NSS Convention. Section business, including election of officers, is done at the meeting.

Back Issues: SACS started in 1983 and copies of back issues of *Compass & Tape* are available. The cost is $1.00 each for 1-2 back issues, $0.75 each for 3-6 back issues and $.50 each for more than six back issues at a time. Back issues can be ordered from the Treasurer.

Overseas Members: SACS welcomes members from foreign countries. The rate for all foreign members is US$4.00 per year and SACS pays the cost of surface mailing of *Compass & Tape*. If you need air mail delivery, please inquire about rates. All checks MUST be payable in US$ and drawn on a U.S. bank.

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Inside

Front Cover: Joan Mylroie, Mike Lace and Andrew Birmingham, mapping Osprey Cave, a flank margin cave on Crooked Island, Bahamas, 2007
Photo: John Mylroie

Back Cover: Map of a flank margin cave from Isla de Mona, Puerto Rico
Cartographer: Mike Lace

ISSN: 1074-596

Published in December 2007
by the Survey and Cartography Section of the National Speleological Society.

Publishing Editor: Patricia Kambesis
Circulation Editor & Printing: Bob Hoke

The editor reserves the right to select which of the submitted materials will be used for publication. Of the material selected, the editor reserves the right to delete redundant or inappropriate material, to correct errors of spelling, grammar, or punctuation, and to edit for clarity, so long as such alternations do not change the meaning or intent of the author(s). In the event that significant changes are contemplated, the author(s) will be consulted and given the opportunity to review the changes prior to publication.

Submissions

All types of materials related to cave survey and survey data, cartography, and cave documentation in general, are welcome for publication in *Compass & Tape.* Manuscripts are accepted in ANY form but are most welcome via email attachment or on CD's. Typed material is next best although we will accept handwritten material as long as it is legible. Artwork is any form. shape or size is also welcome. Send all submission for *Compass & Tape* to:

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Minutes of the NSS Survey & Cartography Section Annual Meeting NSS Convention, Marengo, Indiana July 23, 2007

Attendees: Hubert Crowell, George Dasher, Roger Bartholomew, Bob Hoke, Pauline Apling, Bob Gulden, Thom Engel, Bob Thrun, Mike Futrell, Jim Kennedy, Brent Aulenbach, Rodney Horrocks, Aaron Addison, Dan Lamping, Dan Legnini, Darrell Adkins, Scott House, Chris Genier, Gael Herve, Walt Hamm, Bill Frantz, Jim Coke, Dwight Livingston, Thomas Cottrell, Luc Le Blanc, Doug Medville, Pat Kambesis, Carol Vesely, Howard Kalnitz.

Meeting was called to order at Noon. Meeting minutes from the 2006 meeting were approved.

Hazel Medville spoke at the section meeting about SACS involvement with the International Congress of Speleology to be held in Kerrville, Texas in August 2009. Hazel says that the Congress and the NSS convention will be combined and as a consequence some of the meetings and events will be run differently. For example rather than having a SACS Session, there would be a four Congress sessions on aspects of cave survey and cartography. The sessions organizer of the Congress will choose who will be chairing the session (usually someone from the hosting country and someone international). The deadline for abstracts for that session would be in February 2009, so it will not be possible for someone to submit a talk at the last minute. Also, in addition to the oral presentation, speakers will also be expected to submit papers for publication in the Congress proceedings.

Hazel said that SACS could set up a special symposium on survey/cartography (we will need to talk to Dave Hubbard who is in charge of symposia for the Congress). SACS can choose its own chair person and invite papers. We will need to let Hubbard know before the end of this year if we wish to hold a symposium. Hazel also said that we need to decide what day we wish to have a SAC session meeting.

The cartographic salon will also be run differently than our standard salons. The salon will be the same in terms of map entry and judging. In addition to our standard awards, the Congress also has a "peoples choice" award where those viewing maps vote on their favorite ones. We will need to restrict the number of entries per individual but the number is up to SACS. Maps that have been submitted at previous Carts salons can be submitted to the International Cart Salon.

For the SACS meeting we may have to do a dinner meeting instead of our traditional lunch meeting. Our preference is not to be scheduled against geology or the field trip day, or on Friday.

SACS needs to decide who will be our representatives at the 4 Congress sessions.

For Symposia everyone likes the idea of Data Management and "Cartography for Large Cave Projects." and possibly "Digital Cartography". The following people volunteered to be on the Symposium Steering Committee: Rod Horrocks, Carol Vesely, Aaron Addison, Jim Kennedy, Chris Chenier. They will finalize the Symposium topic.

Following individuals volunteered to be Congress SACS session co-chairs:

Rod Horrocks, Carol Vesely, Howard Kalnitz, Luc LuBlanc, Brent Aulenbach, George Dasher.

Following individuals volunteered to be on the committee to determine salon criteria for the Congress:

George Dasher, Rod Horrocks, Pat Kambesis, Howard Kalnitz, Carol Vesely, Aaron Addision, Chris Chenier.

Election of Officers was held and the original slate was voted back in:

Carol Vesely	Chairman
Howard Kalnitz	Vice-chairman
Treaurer	Bob Hoke
Secretary	Pat Kambesis

Announcements:

The morning session for SACS is complete and went well.

Howard Kalnitz gave a session on "What makes a good map" which was very well attended.

Carol Vesely and Pat Kambesis will be doing a half-day sketching workshop on Friday July 27 in the afternoon.

Luc LeBlanc will be doing a workshop on Auriga location to be determined.

2007 Cartographic Salon. George Dasher was the salon chair. Because of the low number of maps, there were only two categories, Novice and Experienced. The following people served as judges: Novice maps: Pat Kambesis, Howard Kalnitz, Walt Hamm; Experienced: Carol Vesely, George Dasher, Hazel Barton.

George Dasher will be stepping down as Salon Coordinator and Jim Kennedy will take over starting next year.

Officers Report:

Secretary: Nothingto report

Treasurer. Bob Hoke said that a treasurer's report is available for anyone who wants a copy. We have $3900 in the bank. Dues are due.

Editor's report: SACS should publish whatever guidelines they come up with for the International Cart Salon. The editor welcomes volunteers to do "theme issues" of the newsletter.

Elections:

Bob Gulden nominated the existing set of officers. Rod Horrocks seconded. The vote passed unanimously.

Meeting was adjourned at 1:30pm

Minutes submitted by Pat Kambesis, Secretary, SACS

2007 NSS Cartographic Salon Winners

NSS Convention - Marengo, Indiana

Cartographic Salon Chairmanr: George Dasher

A total of 26 maps were entered in this year's Cartographic Salon: 17 in the novice category, 3 in the experienced category, 6 in the expert category, and 3 in the "display only" category. The United States, Mexico, China, and Puerto Rico were represented.

This year's judges included:

Novice Category: Pat Kambesis, Howard Kalnitz, and Walt Hamm

Experienced and Expert: Carol Vesley, Hazel Barton, and George Dasher

Novice Category - Honorable Mention (Green Ribbon)

Owl Cave	Highland County, Virginia	Phil Lucas
Santa Cruz	Quintana Roo, Mexico	Melissa Hendrickson
Jeter River Cave	Montgomery County, Tennessee	Jason Richards

Novice Category - Merit Award (Blue Ribbon)

Russell's Reserve Cave	Bath County, Virginia	Phil Lucas

Notice Cateogory Accepted

Bear Hollow Cave	Gila County, Arizona	Andy Armstrong
Thor's Chore	Tongass National Forest Prince of Wales Island, Alaska	Melissa Hendrickson & Kevin Casey
Chucky's Cave	Edwards County, Texas	Brian Alger
Slot Machine Cave	Tongass National Forest Kosciuko Island, Alaska	Kevin Casey
MZ Cave	Quintana Roo, Mexico	Melissa Hendrickson
Qul Huwa Allhu'Ahad	Tongass National Forest Prince of Wales Island	Melissa Hendrickson & Kevin Casey
Steep Run Cave	Garrett County, Maryland	Dwight Livingston
Chemuyil Side of Road Cave	Quintana Roo, Mexico	Melissa Hendrickson
Powerline Cave 1	Quintana Roo, Mexico	Melissa Hendrickson
Cedar Creek Cave	Bath County, Virginia	Phil Lucas
Lake Cave	Carter Caves State Resort Park	Kevin Kissell
Tonyas Cave	Wayne County, Kentucky	Eric Weaver

Experienced Category - Merit Award (Blue Ribbon)

Werner Cave	Citrus County, Florida	Lee Florea

Accepted -Experienced Category

Roberts Folly Cave	Jackson County, Alabama	Marion Akers
Sotanos des Besito/Milpa/Pjarite	Oaxaca, Mexico	Marion Akers

Professional Category - Honorable Mention (Green Ribbon)

Little Fricks Cave	Walker County, Georgia	Brent Aulenbach
Rumley Bone Cave	Dade County, Georgia	Brent Aulenback
Sloan Cave	Mark Twain National Forest Howell County, Missouri	Mick Sutton
Cueva Catedral	Camuy, Puerto Rico	Patricia Kambesis

Professional Category - Accepted

Cueva de los Indios	Arecibo, Puerto Rico	Patricia Kambesis
Coldwater Spring Cave	St. Genevieve County, Missouri	Mick Sutton

Submitted for Display Only

Dangle Dingle Pit	Rockcastle County, Kentucky	Ron Fulcher
Moonshiners Cave	Rockcastle County, Kentucky	Ron Fulcher
Gap Cave (Cudjo's Cave)	Lee County, Virginia	Bob Gulden

MEDAL (Best of Show)

Qìkèng Dòng and Dòngbà Dòng Novice Category	Wulong County Chongqing Municipality Peoples Republic of China	Erin Lynch & Duncan Collis

Congratulations and thanks to all who entered maps in the Cartographic Salon this year.

Cave Surveys, Cave Size, and Flank Margin Caves

by John Mylroie

The standard measure of cave size, from which the United States, and World, long caves lists are derived, is surveyed length. There have been numerous discussions over the years, in this newsletter and elsewhere, about what portions of the actual survey are considered part of the cave length. The issue of projection of the cave onto a two-dimensional plane, THC or "True Horizontal Cave", must also be considered in a discussion of cave survey length. Modern computer techniques have bypassed this projection problem, at least visually, by 3-D presentations of cave surveys.

Survey length is also used as a filter for state cave surveys. States with many long caves tend to set their filter high, for example, some exclude any cave with less than 10 m of survey, while cave-poor states tend to count almost anything, using a lower filter, such as 2 m, as the inclusion limit. This filter effect has a couple of outcomes. First, it can make state-to-state comparisons of the total number of caves in each state unrealistic, as the ground rules are different. Second, it uses an arbitrary length value as the determiner of cave importance. For example, a 3 m diameter cave passage opening on a hill side, and going in for 9 m to a breakdown blockage, might not be entered in a data base at all as it is less than 10 m in length. However, the cave's significance to understanding, and exploring, an overall cave system could be immense.

Explorational bias also plays a role in cave length discussions. If two caves are segmented by a short, untraversable collapse, their lengths are treated as independent measurements. In the past few decades, this problem has been somewhat mitigated by use of the "cave system" approach, which while still logging the individual explorable cave segments as individual lengths, the length of such segments is commonly summed to give a known minimum length value for the entire cave system. The greatest degree of discussion in this regard has been with lava tube segments, separated by collapsed lava trenches.

Despite the concerns mentioned above, for long stream caves, the overall survey distance is the single most representative value of cave size, for the length of the passage is a dimension much greater than the passage width, or height. The same is partially true for rectilinear maze caves, especially if the length is stated with respect to the area enclosing the maze, as it yields a passage density value. Is a maze cave big because it has a high passage density, or because it has a large areal extent? Some cavers dismiss maze caves with a high surveyed length value as not actually long caves, because although there is a lot of passage, it doesn't really seem to go anywhere.

While cave survey length is the routine indicator of cave size, there are some problems with that use, as indicated above. There are applications where summed cave survey length is not really useful in indicating cave size. How does one consider a large room? Most are surveyed as either a line run around the perimeter of the room, or a series of splay shots taken from a central point or points (or both). For a long stream cave system, a few large rooms surveyed by either method don't change the overall cave length much even if the survey shots for the entire cave are simply summed.

For certain cave types, such as flank margin caves, issues of survey length and cave size take on significant importance. Flank margin caves form in the margin of the fresh-water lens that is found just inside the limestone coasts of landmasses, from continents to islands. The fresh-water lens is a body of water that floats on underlying sea water, as it is slightly less dense. A full explanation of these caves can be found in the recent 65th Anniversary issue of the Journal of Cave and Karst Studies (Mylroie and Mylroie, 2007). For the purposes of this article, flank margin caves form by dissolution caused by mixing of fresh and marine waters within the rock. They are not stream caves, and do not have turbulent water flow. The caves are mixing chambers, and grow and become complex as a result of the enlargement and intersection of these chambers. The caves lack a linear form and are a collection of chambers and rooms. They do not form with entrances, which are a later result of surface erosion or collapse. A portion of a typical flank margin cave, Cueva Aleman from Isla de Mona, Puerto Rico, is shown in Figure 1A. The cave has two main levels, the larger lower level is displayed here (see Frank *et al*, 1998, and Mylroie et al, 1995, for a complete description of the cave). Cueva Aleman is a large cave as flank margin caves go, and when these caves get large, they assume a degree of linearity because the cave chambers only form in the margin of the fresh-water lens, and cannot grow very far inland from the coast. As the chambers enlarge and connect, they form a chain of chambers that are parallel and proximal to the shoreline. This pattern has been called "beads on a string", as shown in Figure 2.

As the caves are a series of globular chambers (Figure 3), to accurately survey them requires that each chamber be properly measured. Perimeter surveys are difficult, as the chambers tend to have very low ceilings on their periphery, and the preferred technique has been to establish a central station or stations, and shoot splay shots of sufficient number to establish the room's dimensions so that the sketch is accurate. Figure 1B is the same as Figure 1A, except that passage detail has been removed and the survey lines added to show how the cave dimensions have been quantitatively fixed by numerous splay shots. The number of stations shown is 190, the number of shots is 233, and the total survey length of those shots is 2,820.67 m, for an average shot distance of 12.1 m. The cave trends ESE to WNW, and the linear distance, taken from the final map, from end-to-end is 325 m. A "width", taken perpendicular to the end-to-end line is 92 m, for an aspect ratio (length over width) for the cave map of 3.53.

The upper level of the cave, shown in Figures 4, is less extensive, but still consists of 124 stations, with 139 shots to produce a sum of 1,475.78 m. The total survey summation for the cave is 4296.45 m. The survey was done by a team of four people in five in-cave days. The cave was surveyed from the WNW end to the ESE end, and the astute observer will see that survey station and shot density drops a little at the ESE end, as time on the expedition was running out, and we rushed to complete the survey. Figure 5 shows the cross sections derived from the survey. A surface survey from the Rio Mona Entrance in the ESE to the West Entrance at the WNW took 16 stations and 16 shots with 376.25 m of survey.

So, how big is the cave? What value should be taken from the survey data to indicate how big the cave is, so that it can be compared to other flank margin caves on Isla de Mona, to flank margin caves elsewhere in the world, and to the more traditional stream caves of continental interiors? While simple summed survey length may be a decent size indicator for long, linear stream caves, it is obvious that simple summation will not work with the intersecting chamber configuration found in flank margin caves. One could go over the final map with a ruler (or plot lines in a computer display), and determine how many linear segments the cave contains, and come up with a derived length that way, but would it be meaningful?

As part of a scientific research project involving Mississippi State University graduate student Monica Roth (Roth, 2004, Roth et al., 2006), a technique was developed to assess flank margin cave size so that the governing factors of cave formation could be discovered. The plan was to determine the areal footprint of the caves. To determine this value, the cave map was scanned, and the cave area was determined by measuring the cave perimeter. This can be done in a variety of computer programs, Monica Roth used AutoCad,

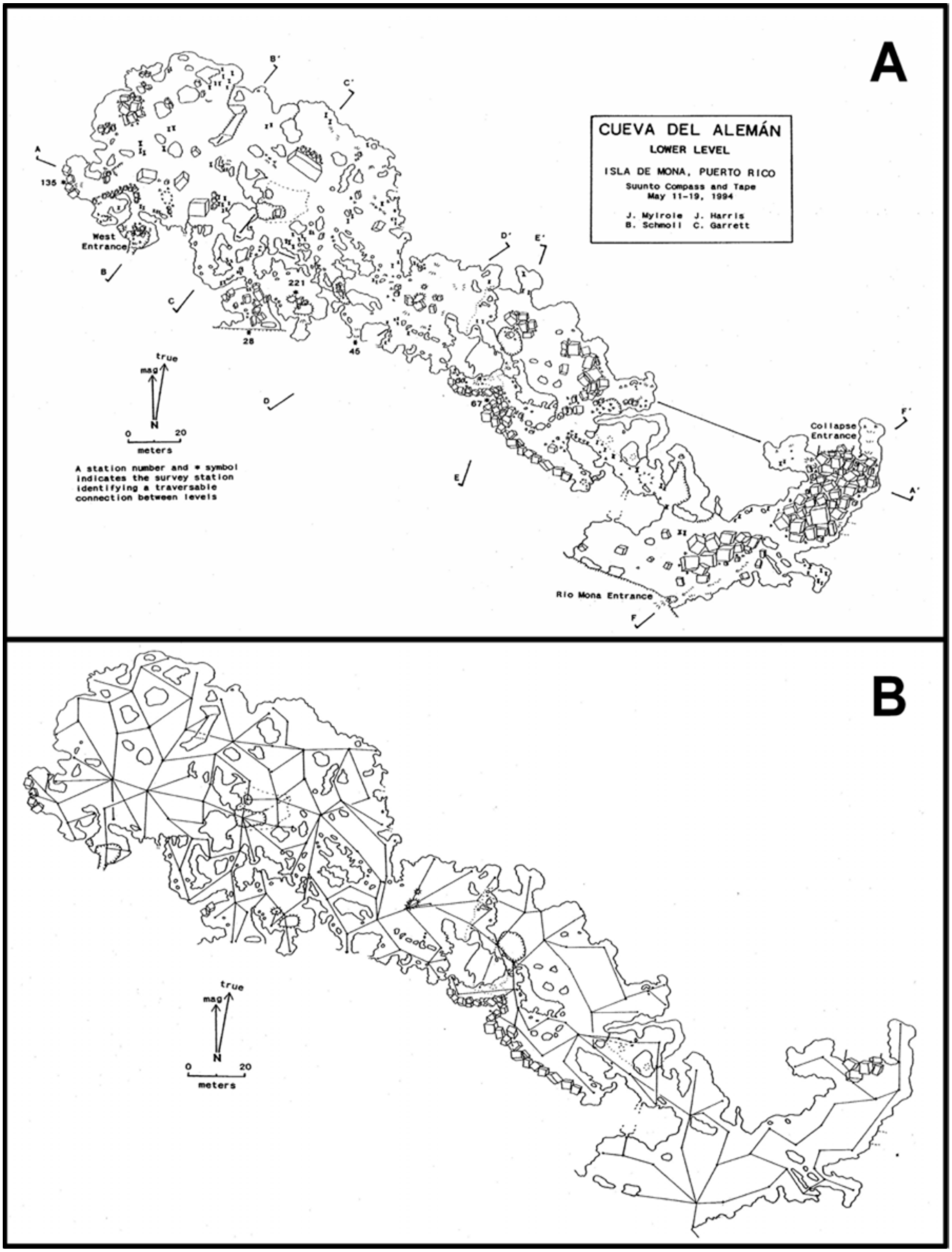

Figure 1. Map of the lower level of Cueva Aleman, Isla de Mona, Puerto Rico. A – Map showing internal cave detail and cross section locations. B – Same as (A) with internal detail removed, and survey station and survey shots displayed.

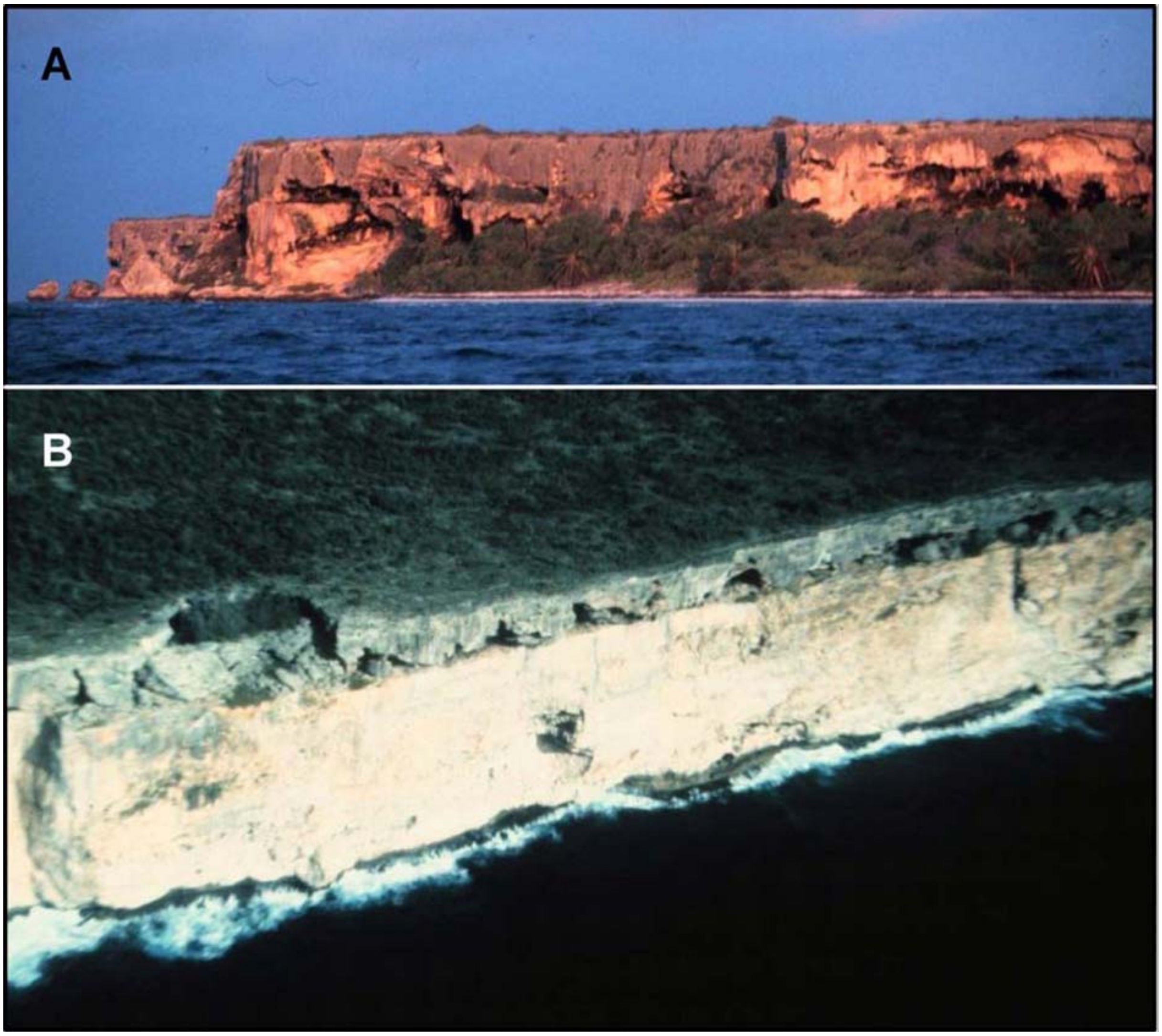

Figure 2. Sea cliffs on the coast of Isla de Mona, Puerto Rico. A – Cliffs at Parajos, 30 m high, showing caves developed in the Lirio Limestone at linear horizons that equate to a past sea level position. B – The southeast coast of Isla de Mona, with sea cliffs 60 m high, and caves developed at the Lirio Limestone and Mona Dolomite contact. Cliff retreat has opened the caves, such that individual chambers appear as "beads on a string".

but we have since switched at the recommendation of Mike Lace to a program from the National Institutes of Health used to map cell interiors, as it is very easy to learn and use. The overall cave area was determined this way, and then the area of any interior bedrock column, pillar, or bedrock body caught within a loop was subtracted out. As these area data were collected by using perimeter measurements, the outer perimeter of the cave was measured, as was the perimeter of each of the bedrock columns, pillars, and bedrock bodies caught in passage loops. While the internal bedrock area values were *subtracted* from the area total, the internal bedrock perimeter values were *added* to the perimeter total as these surfaces were part of the bedrock/water interaction that helped form the cave.

Subsequent analysis of these data by Monica Roth established that flank margin caves had some unusual mathematical properties. The ratio of cave area to perimeter, for flank margin caves of different sizes, produced a straight-line plot. Given

Figure 3. Large Chamber in Cueva Aleman, Isla de Mona, Puerto Rico. The photograph was taken from the B to B' cross section line of Figure 1A, looking WNW into a large chamber. Light from the West Entrance is visible to the left of the person in the photograph. Above and to the right of the person, two circular openings, with flagging tape hanging down, lead into passages of the upper level (Figure 4A & B).

that area is in square meters, and perimeter is in linear meters, the plot was expected to be curved (as it would be for circles or squares of increasing sizes). The significance of that plot is discussed in Roth (2004), Roth *et al* (2006), and in Mylroie and Mylroie (2007), but it is sufficient here to say that this outcome was a very big surprise. It helps explain flank margin cave formation as occurring by the joining of chambers with very irregular perimeters, such that when joined, the increase in cave area is balanced by the increased complexity of the cave wall.

Monica Roth's work also lead to another surprise. When flank margin caves from the Bahamas were plotted as a rank-order graph, that is, the smallest cave to the largest cave, by area, the plot showed three distinct line segments. Again, these results are discussed in the papers mentioned in the paragraph above, but what they show is that these flank margin caves begin as small, simple voids dissolving out in the fresh-water lens. As they grow, they begin to intersect their neighbors, and the gradual increase in size is replaced by a jump in size as two or more chambers connect. These combined chambers continue to grow in size, and then intersect with other chamber combinations, and the cave makes another sudden increase in size. A very interesting outcome of this work is that when flank margin cave genesis and growth was modeled on a supercomputer, using sophisticated programs that took into account water flow, geochemistry, lens geometry, etc., the computer model produced exactly the same size distribution segments as had been derived from Monica Roth's field data (Labourdette, et al, 2007). In addition, it predicted a fourth straight-line segment, down at the very small cave size, in the range of a few square meters in size. Those voids exist, they are present on all the islands where we have done field work. But they are too

CAVE	LENGTH	AREA	PERIMETER	A/P RATIO
McFails Cave, NY	10,470 m	36,245 m^2	14,786 m	2.45
Schoharie Caverns, NY	1,239 m	1,279 m^2	1,345 m	0.95
Nelson Cave, WV	603 m	1,616 m^2	1,379 m	1.17
Yokum Soakum Cave, WV	621 m	1,608 m^2	1,341 m	1.20
Cueva Aleman, Isla de Mona	4,296 m	14,523 m^2	3,344 m	4.34
Cueva del Agua, Isla de Mona	*	8,508 m^2	1,879 m	4.53
Hamiltons Cave, Bahamas	*	8,931 m^2	2,083 m	4.29
Hatchet Bay Cave, Bahamas	*	5,934 m^2	1,383 m	4.29

Table 1. Comparison of four stream caves in the continental United States with four flank margin caves on Isla de Mona, Puerto Rico, and the Bahamas. The A/P ratio is distinct for flank margin caves, and very consistent (* indicates that total survey shot length is no longer recorded for flank margin caves).

small to be fun, so we never mapped them, and they weren't in our database. But the computer demonstrated that it "knew" those little caves were there. Our island work had filtered out the very small caves by explorational bias.

So, once again, how big is Cueva Aleman? It has an areal footprint of 14,533.75 m^2, and a perimeter of 3,343.77 m. The A/P ratio is 4.34. As a comparison, see a few similar measurements (Table 1) done by Monica Roth from linear stream caves in the United States. The A/P ratios are much lower as stream caves do not have complex perimeters. On an A/P graph, they form a separate field from the one produced by flank margin caves.

Because flank margin caves form on the thin margin of a fresh-water lens, they tend to be horizontally extensive but vertically restricted. If the fresh-water lens changes elevation as a result of a sea-level change, and new flank margin cave forms, it may have a connection or two to a flank margin cave produced on an earlier, but slightly different sea-level position and hence, fresh-water lens elevation. Cueva Aleman is such an example, it shows two distinct levels with evidence of a lower third level at the ESE end of the cave (Figure 4). Each level is horizontally extensive and vertically restricted. The significance of this wide-but-low configuration is that areal footprint of the cave is a proxy for cave volume. From a cave science perspective, the cave map becomes a tool for the amount of rock carried away by dissolution, and allows geochemical models to be tested.

Mapping of flank margin caves started out pretty much as a one-team operation as Mylroie and Mylroie (2007) explain. Since the late 1990's, beginning on Isla de Mona and spreading to the Bahamas, mainland Puerto Rico, and the Mariana Islands, cavers have discovered the fun of mapping flank margin caves, as much for the joys of the island locations as for the unique character of the caves themselves. These survey teams have produced hundreds of flank margin cave maps, which keep expanding the database that can be geometrically analyzed to learn more about how such caves form. These cave survey teams understand how the cave maps will be used, and so recognize that passage wall detail, and the presence of isolated bedrock columns and pillars, are important to how the cave is later analyzed. The cave surveying techniques developed on Isla de Mona and elsewhere, primarily attention to passage detail and the use of numerous splay shots, create a mapping strategy. As can be seen from Figures 1 and 4, the cave surveys generate a large number of loops. The abundance of loop closures, and the many splay shots, allows the option of reducing the number of back sights taken, which speeds up the survey. Survey speed can be an issue when on a remote island for a limited amount of time, with limited resources. For example, expeditions to Isla de Mona must bring everything along, including all fresh water. Team

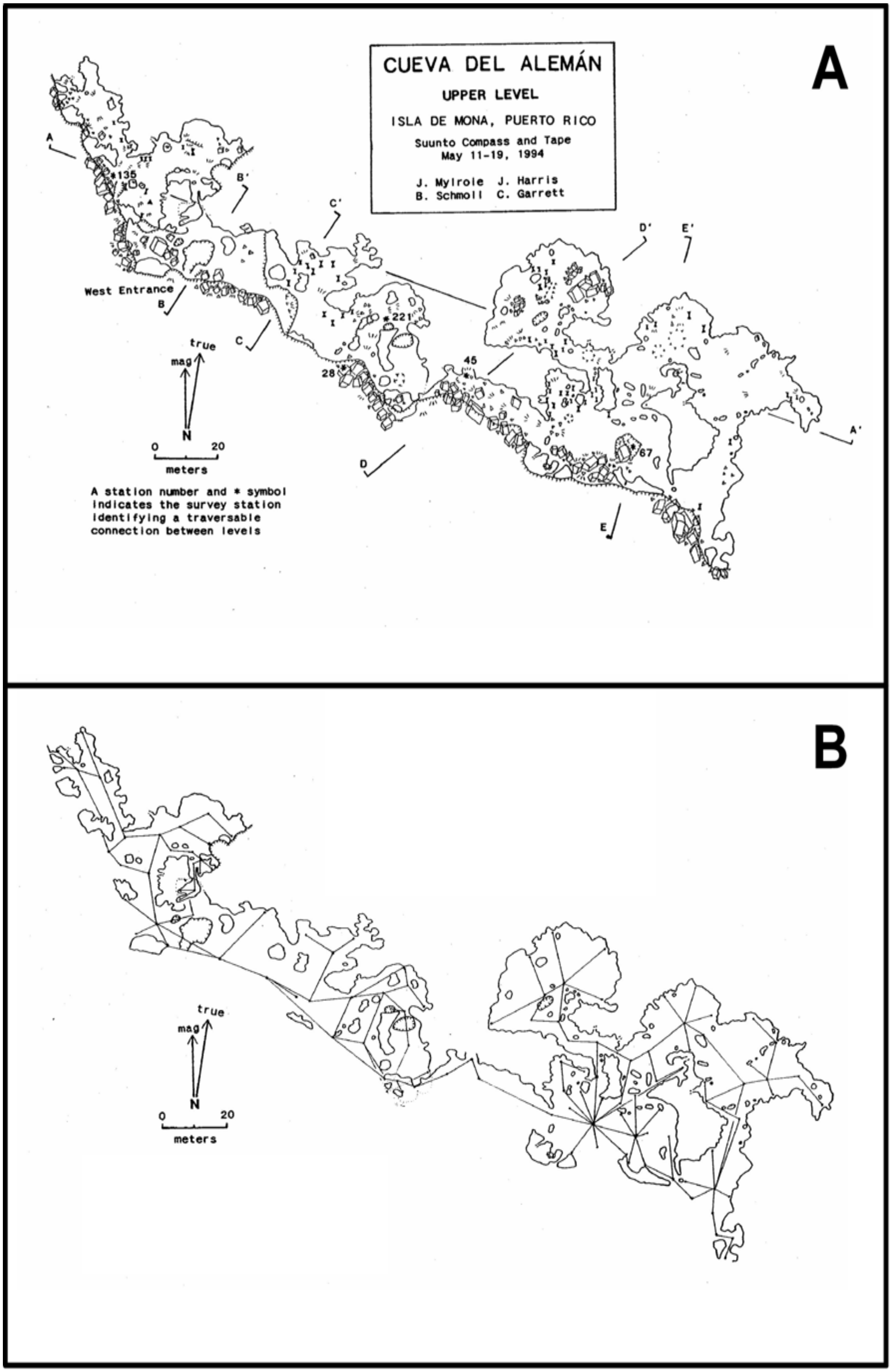

Figure 4. Map of the upper level of Cueva Aleman, Isla de Mona, Puerto Rico. (A) and (B) display the same features as in Figure 1.

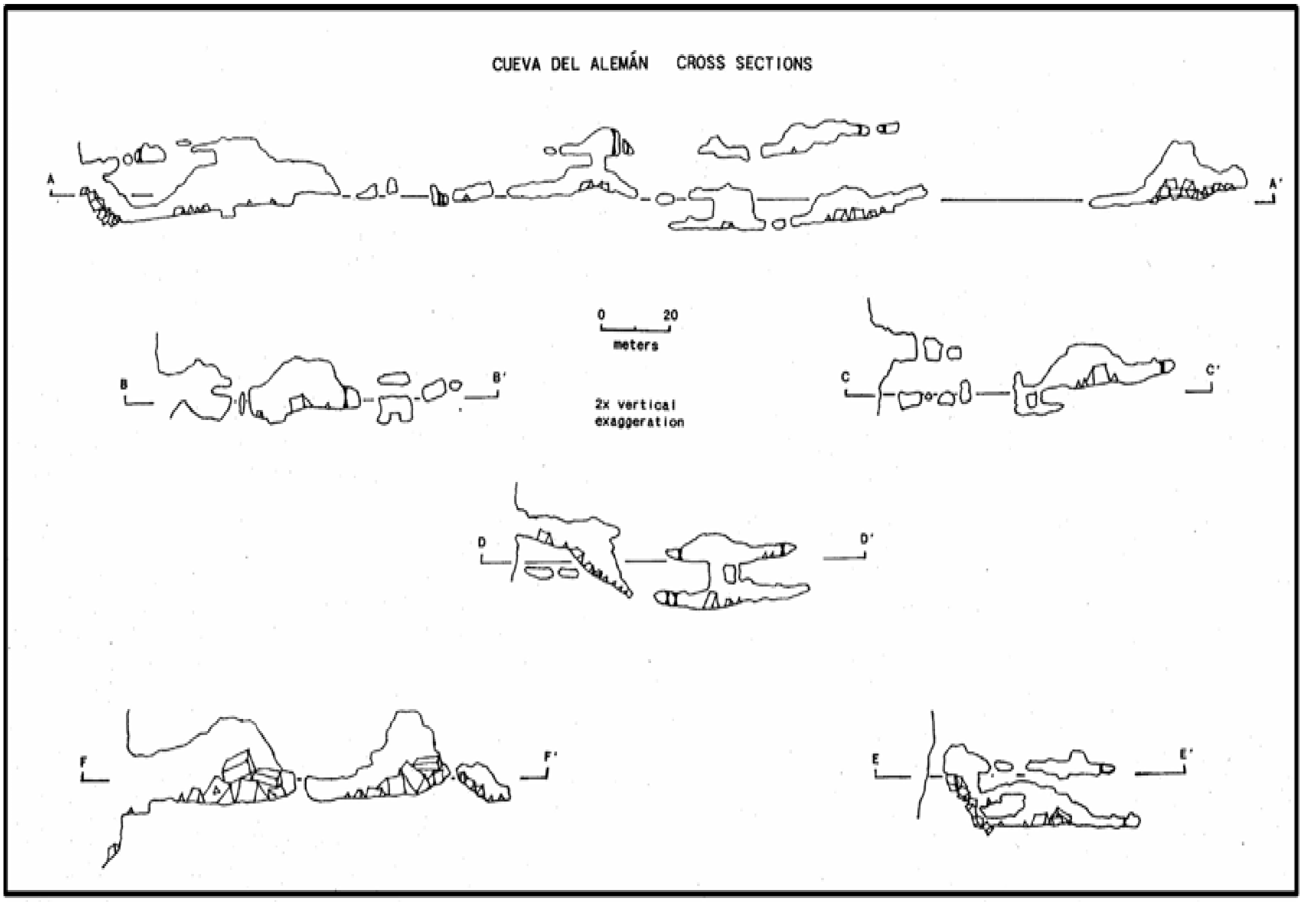

Figure 5. Cross sections for Cueva Aleman, Isla de Mona, Puerto Rico. See Figure 1A for location of the cross sections. The cross sections have a 2X vertical exaggeration.

endurance becomes an issue, even though flank margin caves are among the easiest caves in the world to traverse. The cave map manipulation techniques devised by Monica Roth have recently been applied to other cave types, such as sea caves (Waterstrat, 2007) and tafoni caves (Owen, 2007), and by workers elsewhere, such as on mainland Puerto Rico (Lace, in press), to differentiate these cave types and to help in explaining their genesis.

So cave size is determined in part by how that size can be measured, and how the cave size value will be used in the study of caves. For long, linear stream caves, or lava tubes, simple surveyed lengths, correcting for the relatively few splay shots, produces a reliable and useful answer. For caves that form not as stream conduits, but from the mixing of waters in a non-turbulent environment, the large, irregular chambers thus formed require a different assessment. Cave area appears the best size measure for these type of caves, called "hypogenic" by Art Palmer (1991). Flank margin caves are easily studied by this technique, as they are dominated by length and width, but have a limited vertical extent. But other types of hypogenic caves, such as those of the Guadalupe Mountains of New Mexico, are not restricted in the third dimension, and simple areal footprint is not as successful a measure. The next step is to adequately characterize these three-dimensional chamber complexes.

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Common blunders during the survey trip

Compiled by Bob Hoke and Pat Kambesis

Survey tape errors:

All survey tapes are labelled in increments of either feet or meters. Reading the wrong side between footage or meter increments can results in errors of up to 1 foot or meter.

Some survey tapes have different measuring scales on each side of the tape, for example, feet/meters or feet in-tenths/feet-in-inches. Reading the "wrong" side of the tape with respect to the agreed-upon scale for the survey i.e. meteres instead of feet or inches instead of tenths.

Instrument errors:

Not holding compass horizontally level or not holding the clinometer vertically level (random errors)

Reading wrong side of inclinometer scale (reading percent grade instead of degrees from horizontal)

In compasses that show the front site and back site on the scale, reporting backsite for the frontsite or vice-versa. i.e. small-size numbers on upper half of the scale are the backsite, larger-size numbers on the lower part of the scale are the the front site. (180 degree error)

Decade inversion – reading the wrong direction between major increments on the compass or clino scale (up to 10 degree error)

Magnetic effects on compass caused by batteries, glasses, helmet etc (5-10 degree error – usually caught on backsite). Some of the newer inclinometers can now be affected by magnetics.

Communication errors:

Tape or instrument person reports numbers incorrectly or the sketcher does not hear the numbers correctly. This can easily be avoided if sketcher always repeats numbers back to the survey team. Clinometer reading should always be reported with plus or minus.

Reporting the tie-in station incorrectly to the sketcher. Or the tie-in station may be barely legible and thus prone to being incorrectly identified - this needs to be noted on the sketch.

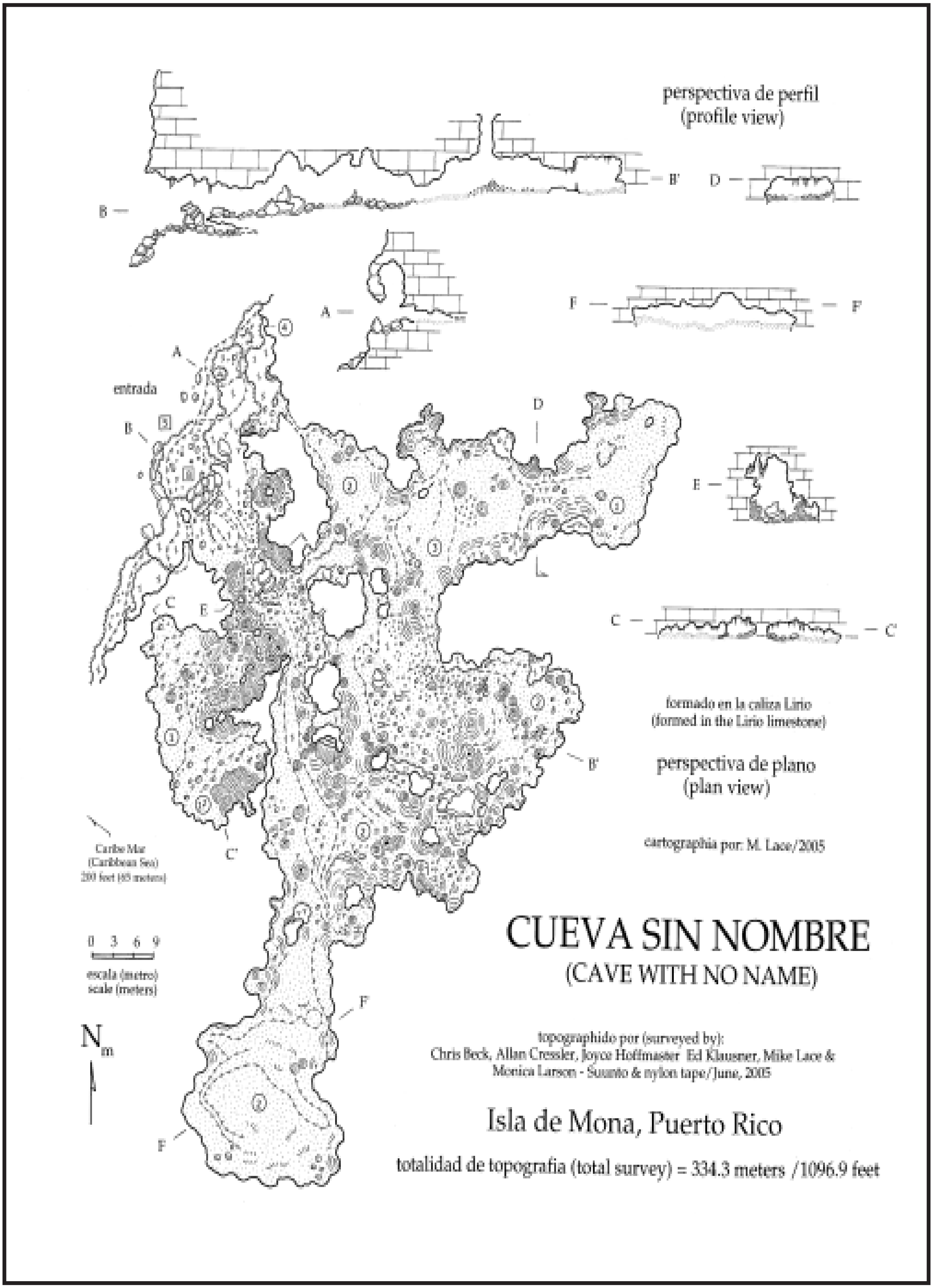
Book errors:

Dyslexia in writing the numbers in the book (random, potentially nasty error)

Failure to record inclination sign (plus or minus) in the book (random, really nasty error)

Sketcher records fore and backsite reversed (this will be apparent in the sketch)

Illegible book - mud, erasures, lousy handwriting (random errors).



perspectiva de perfil
(profile view)
B
B'
D
A
F
F'
E
C
C'
entrada
formado en la caliza Lirio
(formed in the Lirio limestone)
perspectiva de plano
(plan view)
cartographia por: M. Lace/2005
Caribe Mar
(Caribbean Sea)
200 feet (65 meters)
0 3 6 9
escala (metro)
scale (meters)
Nm
CUEVA SIN NOMBRE
(CAVE WITH NO NAME)
topographido por (surveyed by):
Chris Beck, Allan Cressler, Joyce Hoffmaster Ed Klausner, Mike Lace &
Monica Larson - Suunto & nylon tape/June, 2005
Isla de Mona, Puerto Rico
totalidad de topografia (total survey) = 334.3 meters /1096.9 feet