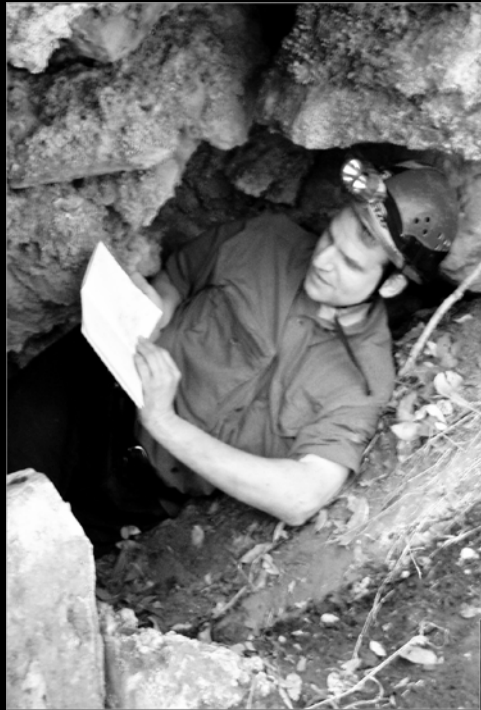


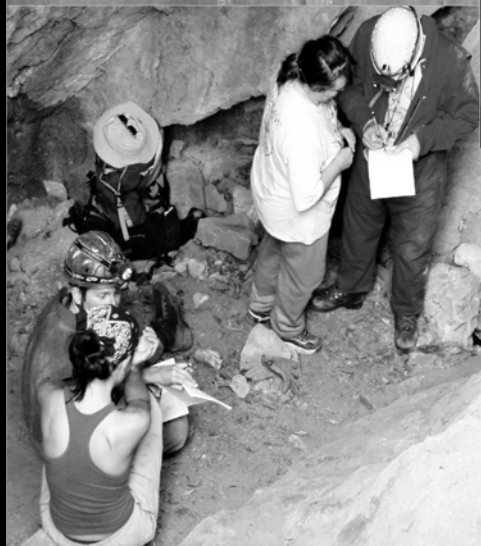
Compass & Tape

Volume 16 Number 1 Issue 53

NSS 2003 Convention Issue



2003 NSS CONVENTION
RANGE OF LIGHT REALMS OF DARKNESS
SKETCHING WORKSHOP



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 quarterly 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 the primary medium 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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From the Editor:

This is a special Convention issue of *Compass and Tape*. This year's convention featured an excellent Cartographic Salon and great sessions on all aspects of survey, cartography and GIS. A variety of instructional workshops and seminars were offered that focused on teaching folks how to map caves, to produce detailed in-cave notes and sketches, and to embark on digital cartography.

The Cartographic Salon featured 54 entries in all categories of experience. The quality of the maps indicates that the Salon has been successful in its initial goals of improving the state of cave cartography. And the shift to going completely digital was most apparent as of the 54 maps entries, only three were hand drafted.

The GIS Symposium that was sponsored by the NSS Geography and Geology Section showed that incorporating cave mapping and GIS is a strong trend that will continue to augment and improve the state of cave and karst documentation and study.

We would like to thank the 2003 Convention Staff for putting on such a great convention.

Front Cover: SACS Highlights from the 2003 NSS Convention in Porterville, California, Photo collage by Pat Kambesis

Back Cover: Scenes from the Pre-convention sketching workshop held at Sequoya Kings Canyon National Park. Photo by Pat Kambesis

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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 as email attachments or on CD's, 3.5 inch diskettes either IBM compatible or Mac format or via email. Typed material is acceptable and 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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Survey and Cartography Section Meeting Minutes

NSS Convention, Porterville, California

August 6, 2003

The meeting began at 12:30 ; Attendees included Brent Aulenbach, Claire Aulenbach, Robin Barber, Carl Bern, Jim Coke, Thomas Cottrell, George Dasher, Art Fortini, Cindy Heazlit, Bob Hoke, Rod Horrocks, Hillarie Howitt, Pat Kambesis, John Lyles, Glen Malliet, Ray Martin, Brian Pease, Nancy Pistole, Bob Richards, Scott Schmitz, Dave Taylor, Bob Thrun, Carol Vesely, Cyndie Waldo, Skip Withrow

Carol welcomed everyone and introduced the officers. The minutes that were still relevant from the last meeting were reviewed. Bob Hoke reported that SACS is in very good shape financially although the interest from the CD is down. Approximately \$10 was lost last year due to a decrease in renewals. Without including prepaid issues of the newsletter, there is \$3664 in available funds.

Pat suggested that the profits from the sketching class should go to SACS rather than the Convention staff. Nancy questioned how any materials fees should be handled. Pat indicated that the instructor would know how many materials to buy since the attendance list is available in advance. Bob Hoke suggested that SACS pay for the class materials since the students will probably become cartographers. Several people agreed that a fee for the course was good since the students would be more serious about attending the class. Cindie Waldo suggested that the class be made a part of convention. Carol thought it would be better to have a nominal fee for the class.

Carol stated that Roger did an excellent job getting the abstracts for the SACS session. Bob Hoke ran the session for Roger this year and suggested that information should be sent out at convention with the goal of getting more talks. None of the other officers had anything more to report.

Carol indicated that SACS had many things on the schedule this year although the laser survey instrument demo fell through due to illness. Another company is sending someone to Crystal Cave with a laser pointing device the week after convention and everyone agreed that and a CD with a virtual cave tour from this demo should be sent out with the newsletter.

Carol and Pat taught 20 students in the sketching workshop that included 3 hours in the class room and 2 hours of in-cave sketching. Art, Glen, and Nancy helped with the class. Most people learned something although there were a few students that didn't know how to survey. In the future,

the requirements of the class need to be stressed so the students can attend a class that coincides with their experience. Carol suggested that the survey class should be taught before the sketching class. Bob Thrun noted that the vertical section handles the wide range of student abilities by scheduling the beginner and advanced class at the same place at the same time. Carol pointed out that this limits the number of available helpers and that more caves were required. Hazel's survey class included 10 people who learned to read stations using bushes at the convention site. Nancy indicated that the cartography class for kids went well. It was taught by a professional surveyor who showed different ways of measuring things. Sketching wasn't included in the class, but all of the students used the tape.

Carol stated that Paul Burger did an excellent job running the computer cartography class and she felt she had learned a lot. Bob Thrun stated that the Monday class was well organized since it concentrated on getting started.

Pat K. indicated that she has another newsletter issue for Bob Hoke on CD this week and that there's another issue waiting on the meeting minutes and the cart salon results. A third issue is slated for the fall since more articles were received this week. Carol suggested that an article on the laser pointer should be included. Bob Hoke suggested that the article include both the laser map and the current map for comparison. Pat agreed to put this in the fall issue and indicated that the website had been updated and includes several articles along with the minutes from last year. George compiled a list of past medal winners for Pat to include in the newsletter and on the webpage.

Rod Horrocks was salon chair this year and stated that there were 54 entries this year including 16 states, 5 countries, and 30 cartographers. 29 entries were in the apprentice category, 15 were in the experienced, and 10 in the master/pro categories. There was a lot of positive feedback on the divisions for the competition and he suggested that the master/pro category not include paid cartographers, but just professional ones. Nancy stated that there should be a separation between those who make maps and those who only have the evenings to work on them. Carol pointed out that professional cartographers also have access to better equipment. Pat didn't think that this was a resource issue and pointed out that there are different standards for different categories. Nancy pointed out that a beginning cartographer might be intimidated by their inability to access better

equipment. A discussion on how to determine if someone is professional or not ensued. It was decided that the apprentice category included cartographers who had never won a ribbon, the experienced category was for those who had won a ribbon of any color, and the master category included those who had been awarded one or more medals.

Rod indicated there were 6 judges with 2 for each category and Rod acted as a third in case of disagreements. George will coordinate the cart salon next year. Carol indicated the need for a list to verify which category each cartographer should be in. Rod stated that George is compiling this list and will have it available for next year. George noted that the photo salon personnel would like the cart salon results sooner.

Pat indicated that she would like the salon critique sheets xeroxed before the cart critique session so they can be use for the newsletter critique issue. A few maps will be picked for the newsletter critique issue and Pat will get the permission of the cartographers on Friday. Both Pat and Jim Kennedy have been taking pictures of the maps for the newsletter

Bob Hoke was notified by the NSS that a rule requiring a \$3 fee for each entry in the cart salon has been on the books for years although it hasn't been enforced in the past. No one is interested in collecting the money and there was concern that the fee may discourage participation. Failure to collect the fee could result in the omission of the cart salon awards at the Thursday night ceremony. This year SACS

paid the fee for all entries, but something needs to be done for future salons. George stated that the NSS is paying about \$50 total for ribbons and postage for people who don't attend convention every year, so the NSS is making money off the entry fees. Bob Richards indicated that it only costs \$1 per entry for the print salon and \$4 per entry for the slide salon and questioned the difference in cost. Pat suggested that SACS should pay for their own ribbons and postage even though the awards may not be presented at the Thursday night ceremony. Bob Hoke pointed out that the vertical section does its own awards. George suggested that it's important to maintain a presence at the ceremony for recognition purposes. Carol suggested that the price should be negotiated down from \$3. It was decided to notify the NSS that SACS would like to take responsibility for the cart salon and fund it internally in the future. Expenses this year are to be sent to Bob Hoke since SACS is paying for the cart salon entries this year.

All of the incumbent officers were interested in maintaining their positions and no one wanted to run for election. Rod motioned that the incumbents continue to serve their position and this was voted in. The meeting was adjourned at 1:38 pm.

Submitted by Robin Barber, Secretary

Instructional Workshops and Sessions at the 2003 NSS Convention

Pat Kambesis

This year's convention offered a varied array of instructional workshops and sessions on all aspects of cave mapping, sketching, digital cartography and GIS. A brief summary of the workshops conducted during this year's convention follows:

Sketching Workshop:

Instructors - Carol Vesely and Pat Kambesis

Assistants: Art Fortini, Nancy Pistole,

Glen Malliett

The Sketching Workshop was conducted at Sequoia Kings Canyon National Park. This was an all day workshop held on Sunday, August 3, 2003. The workshop was designed for cavers who familiar the basics of cave surveying and were interested in learning how to "sketch to scale".

The workshop began with a morning of classroom instruction. Topics covered included setting up the survey book, plotting the survey line, and the review and use of cave map symbols. Everyone was instructed on sketching the cave in plan and cross sections. Those individuals with some sketching experience were instructed on adding the profile component to the sketch.

Since a number of participants did not have any mapping experience, part of the session was spent on making sure that everyone was familiar with the basics of cave survey. A short hands-on session was conducted in order to get everyone up to speed on instrument reading, station measuring and placement, and plotting the survey line.



Nancy Pistole instructs students on sketching-to-scale at the classroom portion of the Sketching Workshop.

Photo by Pat Kambesis

The second half of the session was conducted in two small caves at Sequoia Kings Canyon National Park. Art Fortini, Nancy Pistole and Glen Malliett provided field assistance in running the survey line and offering instruction on making the in-cave sketch. A total of 20 people participated in the workshop.

Digital Cartography Workshop:

Instructor: Paul Burger

The Digital Cartography Workshop offered twice during convention week (August 4 & 6th). The purpose of the workshop was to teach the fundamentals of digital cartography to those who were familiar with the basics of map drafting using the “standard” mylar and pen method.

Burger covered how to bring pencil drafts, old maps, or survey notes into the digital environment and turn them into fully “inked” maps. Topics covered included effective use of layering to make maps more versatile, and basic tools that can be used to make drafting computer maps much easier. All techniques were applicable in most major drawing programs including Freehand, Illustrator, Corel and Canvas.

Both sessions were packed and a total of 40 + people participated in this workshop.

Junior Speleological Society (JSS)

Cartography Session:

Instructor: Steve Deveny, Professional Surveyor

This class was held in two short sessions on Tuesday, August 5th at the Porterville College Campus. The class was aimed at young cavers and provided them with basic instruction on survey team responsibility during cave mapping trips. The course included hands-on practice with survey equipment and also covered the principles of use of a GPS unit.

Introduction to Cave Surveying Workshop

Instructor: Hazel Barton

This workshop was conducted as an all-day session on Tuesday August 5th. The class was held on campus and was aimed at cavers with no previous experience surveying caves. There was a classroom section which went over the basics and principles of surveying. The class then moved outside on campus where students were given the opportunity to practice the techniques of setting and measuring stations and reading instruments. A total of 10 people participated in Hazel’s workshop.

GIS & Digital Mapping Symposium

Coordinator: Bernie Szukalski

The NSS Geography and Geology Section sponsored a GIS Symposium at this year’s convention. Papers and presentations focused on various facets of cave and karst GIS and digital mapping. The Symposium was held on Friday morning, August 6, 2003.

2003 NSS Cartographic Salon

Salon Coordinator: Rod Horrocks

Judges: Gordon Birkhimer, Lee Florea, Jim "Crash" Kennedy,

Pat Kambesis, Nancy Pistole, Bob Richards



Bob Richards scrutinizing a map in the Experienced Category of the 2003 Cartographic Salon.
Photo by Pat Kambesis

The 2003 Cartographic Salon had 54 map entries from 30 different cartographers showing maps from 16 states and 5 foreign countries. The Salon was divided into three categories:

Apprentice- cartographer has never entered or has never received a Cartographic Salon Award. (Judges: Lee Florea, Gordon Birkhimer)

Experienced - cartographer has received at least one Cartographic Salon award
(Judges: Bob Richards, Nancy Pistole)

Masters/Professional - cartographer has won at least one medal or is a professional cartographer.
(Judges: Pat Kambesis, Jim "Crash" Kennedy)

Salon Awards include Honorable mention (green ribbon), Merit Award (Blue Ribbon) and Best of Show (Medal).

In this year's salon there were 29 Apprentice entries, 15 experienced and 7 master/professional maps entered. Two display maps were also shown. The small, round art display building served as a perfect location to show the many maps that were entered in the salon. The winners were announced at the Thursday evening program and a critique was held on Friday morning. This year, two medals were awarded; one to Hazel Barton for her map of Fairy Cave, CO, and the second to Peter Bosted et al, for his Atlas of Lilburn Cave, CA.

Each year a salon critique is held on the Friday morning of Convention Week. All of the judges and the salon coordinator attend the critique in which the judging criteria for each map is discussed with the cartographers and all other interested parties. This year's awards and a full list of all entries are as follows:

2003 Cartographic Salon Winners

Cave	Location	Cartographer	Award
Apprentice Category:			
Krem Maw Rang Naisaw #2	India	Allison, S.	Blue
Pahihi Gulch Cave	Hawaii	Szukalski, B.	Blue
Short Cave	Kentucky	Evans, M.	Blue
Spirit River Cave	Borno	Malliet, G.	Blue
Systems Key Cave	Nevada	Patel, K.	Green
Ponderosa Cave	California	McDonald, H.	Green

Cave	Location	Cartographer	Award
Experienced Category:			
Campbell Coon Cave	Tennessee	Henry, D.	Blue
Cueva des Setzol	Guatemala	Pistole, N.	Blue
High Hopes, Lech	New Mexico	Burger, P.	Green
The Promised Land, Lech	New Mexico	Barber, R.	Green
Lilburn Cave Atlas	California	Bosted, P	Medal
Masters/Professional:			
Admirals Cave	Bermuda	Richards, B.	Blue
Zina Cave	Alaska	Allred, C.	Blue
Fairy Cave	Colorado	Barton, H.	Medal

2003 Cartographic Salon Entrants

Cartographer	Cave	Cartographer	CaveLocation	Category
Cooper, M.	A Cave		CA	Apprentice
Allison, S.	Krem Maw Rang Naisaw #2		India	Apprentice
Allred, C.	Zina Cave		AK	Master/Pro
Allred/Richards	Kazumara Cave Atlas		HI	Display
Andrews, C.	Snail Shell Cave		Borneo	Experienced
Aulenbauch, B.	Fox Hole		AL	Display
Barber, R.	The Promised Land, Lech		NM	Experienced
Barton, H.	Fairy Cave		Co	Master/Pro
Barton, H.	South Peters Cove Sea Caves		CA	Master/Pro
Bosted, P	Lilburn Cave Atlas		CA	Experienced
Bunnell, D.	Upper Natural Bridge Cave		CA	Experienced
Burger, P.	High Hopes, Lech		NM	Experienced
Cartographer	Map		State	Category
Evans, M.	Short Cave		KY	Apprentice
Florea, L.	Briar Cave		FL	Experienced
Ganter	La Cueva de los Ojos		NM	Master/Pro
Ganter, J.	Collapse Cave		NM	Master/Pro
Ganter, J.	Psyche Cave		NM	Master/Pro
Gee, M.	Half Hill Cave		TX	Apprentice
Gee, M.	Three Skylight Cave		TX	Apprentice
Gilleland, T.	Offering Cave		Belize	Apprentice
Greaves, P.	Diarrhea Dip Cave		CA	Apprentice
Greaves, P.	Grapevine Gulch Cave		CA	Apprentice
Greaves, P.	Shoo Fly Cave		CA	Apprentice
Gulley, J.	Vortex Spring		FL	Apprentice
Henry, D.	Campbell Coon Cave		TN	Experienced
Kowallis, B.	Interstate Cave		NV	Apprentice
Kowallis, B.	Red Baron Cave		UT	Apprentice
Kowallis, B.	Spanish Moss Cave		UT	Apprentice
Leissring, M.	Grapevine Gulch Cave		CA	Apprentice
Leissring, M.	Pandoras Box		CA	Apprentice
Leissring, M.	Poleta Cave		CA	Apprentice
Leissring, M.	Rabbit Hole Cave		CA	Apprentice
Leissring, M.	Scat Cave		CA	Apprentice
Leissring, M.	U-Turn Cave		NV	Apprentice
Malliet, G.	Spirit River Cave		Borno	Apprentice
McDonald, H.	Ponderosa Cave		CA	Apprentice

Patel, K.	Systems Key Cave	NV	Apprentice
Petrie, G.	Ape Cave	WA	Experienced
Petrie, G.	Chubby Bunny and Pickings	WA	Experienced
Petrie, G.	New and Jar Caves	WA	Experienced
Petrie, G.	South Kipuka System	WA	Experienced
Pistole, N.	Cueva des Setzol	Guatemala	Experienced
Pistole, N.	Nimblaja Cueva de Semococh	Guatemala	Experienced
Richards, B.	Admirals Cave	Bermuda	Master/Pro
Rogers, B.	Bear Gulch	CA	Experienced
Rogers, B.	El Calderon Bat Cave	NM	Experienced
Sheltons, J.	Great X Cave	WY	Apprentice
Swartz, J.	Rumbling Falls Cave	TN	Apprentice
Szukalski, B.	Pahihi Gulch Cave	HI	Apprentice
Szukalski, B.	Caves of the Walsinghal		
	Karst Area	Bermuda	Apprentice
Szukalski, B.	Wind Cave	SD	Apprentice
Thompson, T.	Big Spring Cave	MO	Apprentice
Thompson, T.	Boiling Spring Cave -		
	Pulaski Co.	MO	Apprentice
Thompson, T.	Boiling Springs, Texas Co.	MO	Apprentice
?	Hairy Fungus Cave	WA	Apprentice

The Survey and Cartography Session of the 2003 NSS Convention was held on Wednesday afternoon, August 6, 2003 at the Communications Arts Building of the Porterville College campus. A total of eight papers were presented on various aspects of cave survey and cartography. Following are the abstracts for the session.

Survey & Cartography Session

Session Coordinator: Roger Bartholomew

Cartography of Lilburn Cave

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Lilburn is a 20 mile long, 3-dimensional maze cave that presents interesting cartography challenges. This has led to the development of a multi-level quadrangle system. Approximately 90 quadrangle maps are needed to cover the entire cave. For convenience in reproduction and in-cave use, the text and level of detail are sized for I V by 17" format, but can also be used in 8.5" by I I " format. Up to four vertical slices are made for each plan view. The slices are selected on a station-by-station basis for the best clarity, rather than strictly by elevation. A special code for each station is used by a custom plot program to decide which level(s) a given station is to be plotted on. Typically, 3 to 5 stations of overlap are used at level transitions. Each transition is given a number, and prefixed by "U" or "13" to tell the reader whether to look "up" or "down" a level for the corresponding number. A program was written on a Mac to make the line plot and borders given the code for a given quadrangle. The cave passage and details are drawn in Canvas or Illustrator. This makes it much easier to make changes than using pen and ink. Additional maps to visualize the overall cave have been made with custom software, including stereo 35-mm slide pairs. Examples of the latter will be passed around to the audience.

Compass/Inclinometer Using Laser Pointer for Cave Surveying

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A new device has been developed that incorporates a small laser to make compass and inclinometer use easier. The laser is used as a pointer, not as a distance measurement device. The device is a 2 piece folding unit with a laser pointer and inclinometer on the front piece and the compass on the back piece.

To use the compass, the rear half of the device is approximately leveled with the back at the "from" station, and the front half tilted so that the laser points as the "to" point. The vertical plane containing the survey points also contains the line of laser light and the axis of the compass. The compass is read in the usual manner. A telescoping extension is useful when the "from" station is on the ceiling of a passage. To read inclination, the hinge of the device is held on the "from" survey station, and the laser is pointed at the "to" survey station. The inclinometer is read in the normal manner. Two types of inclinometers were tested, an electronic version and a mechanical version. Both can be used without looking at them, and hold their readings once they are set.

The device is about 6 inches long when folded and about 2 inches in "diameter". The device has been used in cave surveys and has performed well. The device has been tested around a 4-sided loop, and backward and forward loops have closed with about 1 degree of average error horizontally and 0.3 degree vertically.

Computer Generated Cave Maps: What you need to Set Up and Be Successful

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The art of cave cartography did not involve computers just a few years ago. Pen and ink, mylar and large drafting tables have been replaced by the mouse, monitor and software. The new techniques today are easier to use and master and they have far more precision and options for creating beautiful cave maps. Graphics software is replacing the manual cartography methods used by cavers in the past as home computer hardware and software become cheaper and easier to use. The hardware and software used for creating professional looking maps will be discussed in general terms.

Understanding how to set up and execute using these tools is essential in creating a successful computergenerated map. The steps used to set up and create a professional looking cave map and what the map judges are looking for in the Cartography Salons will be presented.

DJVU Map Encoding for Display on the Web

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Using DJVU encoding has given the Raders Valley Project the ability to communicate visually to project participants using highly zoomable, crisp, small file size images of current working maps. Further information such as "zoom startup" and embedded hyperlinks in the image further the usefulness of this technology. To begin the process cave project participants must download a small browser plug-in that will allow the embedded images to be loaded via their web browser. Then maps both working and complete can either be scanned or opened in the DJVU editor and encoded for display on the web. Using the zoom tools in the browser the project participant can now zoom in to specific areas with very little loss of detail to focus on areas of interest within the survey. This technology opens the door to sharing maps with incredible detail and a small file size via the web.

I have been using DJV_U encoding for years and this presentation will focus on the workflow process of moving scanned images and digitally saved maps to the web via an embedded DJVU image.

Morphing Digital Working Sketches to Line/Wall plots using Manifold 5.5

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Registering and morphing a rough digital working sketch to a line plot only accomplishes part of the complex process needed to accurately trace a final digital cave map. To fully accomplish a digitally "traceable" bottom layer requires that the passage walls from section to section match up and further that the left and right points at each station are registered and morphed along with the sketch to the line plot points. I have developed a workflow process using Manifold 5.5 to effectively accomplish this. First, working sketches are scanned and then opened in Manifold. A separate lineplot image with tics for left/right is then opened in the same project and control points placed on both images at spots corresponding to survey stations, left/right points and wall segment joining points. Using a geo-registering method that Manifold calls "Affine" the rough sketch is then morphed

onto the line plot and the assembly begins piece by piece. The final result is a fully aligned and digitally traceable cave map layer. Experience has shown that proper order in placing the control points results in consistent and highly accurate results.

This presentation will focus on examples of the workflow process and a quick demo of the actual registration of a rough working sketch segment to a cave surveys line and wall plot.

Regional Studies for Underwater Caves in Quintana Roo, Mexico

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Underwater cave survey techniques integrated with the Global Positioning Service (GPS) disclose underground drainage configurations and cave relationships in eastern Quintana Roo, Mexico. The present study area incorporates 6300 square kilometers. Garmin II+ and Garmin V GPS receivers, calibrated for civilian applications, verified entrance coordinates at independent underwater cave systems. With Selective Availability disabled, a 12 channel receiver reports a three to nine meter Estimated Position Error at coordinate collection locations. Correlating distant cave systems by conventional land surveys in the indigenous jungle environment is problematic; those surveys exceeding 1.5 kilometers encourage GPS applications. A database of 230 GPS locations for underwater karst formations, and 74 km of land survey provide surface control points for the regional analysis.

Safety and environmental issues require underwater cave explorers amend traditional cave surveying methods. A permanent guideline, knotted at fixed intervals, is positioned in new passage during initial exploration. Survey data is collected on the exit utilizing a depth gauge and compass, while knotted segments of the guideline are tallied between survey stations. Eleven underwater caves in Quintana Roo are surveyed by more accurate methods. Taped survey lengths, compass backsights, and measuring passage attributes are means used to create these maps. A total of 91 underwater cave surveys (431 kilometers of surveyed underwater passage) are incorporated in the regional study. Computer software converts raw cave survey data into georeferenced coordinates.

The Effects of Lava on Compass Readings

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Cavers mapping lava tubes well know that compass readings are not always what they should be. This is many times incorrectly attributed to the attraction of the magnetized compass needle to magnetic material (magnetite) contained in lava. However, the main causes of unwanted needle deflections are due to distortion of the magnetic field because:

- A. property of magnetic material called susceptibility and:
- B. Magnetization of magnetite from lightning strikes.

Knowing how these effects arise and their characteristics may aid the mapper in achieving better readings. Fore- and back-sights cannot correct for readings caused by distortion of the earth's

Update on 3D Mapping of a Portion of Laurel Caverns, PA.

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In June, 2002 a portion of Laurel Caverns, PA was scanned with a DeltaSphere-3000 device built by 3rdTech, Inc. in Chapel Hill, NC. It is a scanning, time-of-flight laser rangefinder that takes up to 20,000 measurements per second. The laser is directed around the environment with mirrors and motors, capturing 360 degree panoramas that have a 150 degree vertical span at a resolution of about 13 samples per degree (in each direction). The laser measures distances to the first surface it hits, up to about 15 m away, with an accuracy of about 8 mm. To overcome occlusions or shadows, range scans are taken from multiple locations. Sufficient overlap between scans allows them to be aligned with one another during post-processing.

For each range scan, there is also a color panorama acquired with a Kodak Professional Digital Camera. A wide-angle lens is used, providing sufficient color imagery at a resolution that is close to that of the range scan. Average time for a scan is about 30 minutes. To complete the work, we spent 6.5 hours scanning from 9 locations.

Post-processing has involved several steps. The color images are fused together with the range data, coloring each range sample. We use the Polyworks software tools from Innovmetric coupled with some of our own custom tools.

Since our presentation last year, we will show, finished alignment of the multiple data sets.

The use of GIS to study and manage caves and karst is a relatively new and rapidly growing field. The NSS Georaphy and Geology Section sponsored a GIS Symposium at this year's convention. Papers and presentations focused on various facets of cave and karst GIS and digital mapping. The Symposium was held on Friday morning, August 6, 2003.

GIS & Digital Mapping Symposium

Session Coordinator: Bernie Szukalski

ArcPAD GIS Mobile Software in Cueva Del Tecolote, Tamaulipas, Mexico

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The March 2003 expedition to Cueva Del Tecolote cave system in the Proyecto Espeleologico Purificacion karst study area made extensive use of ArcPAD GIS software. The expedition had 23 cavers in 7 survey teams to send to over one hundred possible leads. The GIS project consisted of the existing cave survey as a layer imported from WALLS cave surveying software, a layer of all other known caves in the area, a scanned version of the topographic map, scanned survey notes, and a shapefile of all the leads for the expedition. Leads were symbolized as point features and linked to the corresponding survey note scans. All of the data was loaded on to an IPAQ handheld computer for the expedition. A special "wetbag" designed for use with computers was used to eliminate humidity and water damage to the unit. The IPAQ was used for six days at Camp I and also on long survey trips to different areas of the cave.

Using ArcPAD on this expedition was a big success. Teams with little to no familiarity with a given area of the cave could simply choose a lead on the handheld, and retrieve the survey notes for the area. Leads were color coded based on the type and quality of lead, allowing survey teams to be as productive as possible.

Having the handheld computer in the cave also provided programs such as Word and Excel for writing trip summaries and correcting math errors while in Camp 1.

Assessing Perennial Drainage, Turnhole Bend Basin, Kentucky

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Drainage density is the summed length of all streams in a basin divided by the basin area. It is a measure of average length of streams per unit drainage area and describes the spacing of the drainageways.

Initially, four methods were developed to estimate perennial drainage density within the highlykarstified Turnhole Bend Basin, Kentucky, resulting in values ranging from 0.24 km/km² to 1.13 km/km². Since mapped cave streams represent only a fraction of the total underground streams within the study area, the actual values are likely much higher. With each method, by increasing detail, higher perennial drainage density values resulted. Therefore, efforts were taken to devise a model that would reflect a reasonable upper drainage density value.

Using ArcInfo 8.3 and Visual Basic.net, an idealized karst drainage model was developed. Using a square drainage basin, a drain point along the basin's perimeter is randomly selected. A number of sinkhole drains (x) are randomly located in the basin. Repeatedly running the model, a least-distance stream network yields a pattern consistent with the formula:

Anhert and Williams (1998) counted an average of 74 sinkholes per km² for the Turnhole Bend Basin Sinkhole Plain. Applying the provisional equation, perennial drainage density is 6.83 km/km². Though this value is derived from an idealized model, quantitative measures of subterranean stream networks hold potential as powerful analytical tools in the understanding of karst.

The BeCKIS Project - Establishing a GIS for Cave and Karst Conservation in Bermuda

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ESRI Cave and Karst Program &
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The islands of Bermuda, located in the Western Atlantic Ocean approximately 1000 km off the coast of North Carolina, contain many significant caves. Bermuda is a densely populated country with approximately 65,000 inhabitants and a land area of roughly 57 square kilometers. Approximately 150 caves have been discovered in Bermuda, many of which are profusely decorated with delicate and unique speleothems. Many caves include passages which extend to sea level and contain deep anchialine pools and extensive underwater networks. A large variety of cave-adapted life, including previously unknown species, have been found in these underwater caves. Of the species identified in Bermuda's caves 25 are currently on the critically endangered species List. The high population density and resultant development pressures, vandalism, pollution and other negative factors have significantly impacted and continue to threaten Bermuda's unique cave resources.

In early 2002 the Bermuda Cave and Karst Information System (BeCKIS) project was established with the primary goals of increasing public awareness of Bermuda's caves and cave life, increasing awareness of negative impacts on these resources, and promoting the scientific study of Bermuda caves. The BeCKIS utilizes GIS software to maintain a database and inventory of cave locations and incorporates field observations and other measurements along with both dry cave and submerged cave survey data and maps. GIS maps have been used to establish baseline quality information from past observations, and additional GIS projects are proposed.

Inexpensive Lineament Analysis for Discovering Ingress Nexus (ILADIN)

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An inexpensive technique has been developed that increases the probability of finding cave entrances in undeveloped karst and pseudokarst terrain. The first trial of this technique was done in Sequoia National Park on 10/05/2002. A small solution cave previously unrecorded by the National Park Cave Survey was found in the area (+/- 5,000 ft.²) ILADIN predicted would have a high probability of containing cave

entrances. Three choked solution passages, one with moderate airflow emanating from it, were also found in ILADIN highlighted areas. ILADIN's second trial, in an area known to form sandstone pseudokarst caves, also yielded a series of promising cave entrances.

Inventorying Cave Features Using ESRI Arcpad Software

*Jon Jasper
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Many locations of findings, project activities, and research in the caves have been lost due to a lack of a good system for organizing spatial data. Using a georeferenced map of the Timpanogos Cave System, significant features throughout the cave such as electrical wiring, historic artifacts, rare formations, and monitoring stations will be mapped and inputted in the field using ESRI ArcPad software and a Pocket PC iPaq. This inventory will be organized so that spatial relations can be studied, data can be quickly found through hotlinks, and management activities can be documented.

Somerset Northern Bypass Karst GIS

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The 1-66 Special Project of the National Speleological Society was formed to study and document potential impacts of the construction of an interstate highway (1-66) across the karstlands of Southern Kentucky. The present project focuses on an independent utility bypass of Somerset, KY designed to serve as a segment of 1-66. In the fall of 2001, the Kentucky Transportation Cabinet began the project planning phase and presented potential alternatives in April, 2002. The corridor is along the Cumberland Escarpment; host to several rare and sensitive species.

A karst GIS was developed for analysis using ArcView 3.2A software. Vector files used include: Corridor and alternates, urban areas, suburban areas, woodlands, streams, rivers, wetlands, sinkholes, cave entrances, springs, conduit probability polygons, flowpaths, karst occurrence.

Raster images included USGS 7.5-minute topographic and geologic maps, and Digital Orthographic Quarter Quadrangle aerial photography. Forty-eight (48) karst features were documented during the study within 13 karst aquifers contained in 10 surface watersheds. Of these karst features 28 were springs, four of which serve as headwaters of

major streams. A coverage of karst occurrence was developed subdividing the corridor into 10 land units, 8 of which are karstic. The corridor covers approximately 46km², 79.2% of which is karstic. Of this karstic land, 48.4% is sinkhole plain. It is clear from this study, that the Somerset Northern Bypass is planned within a highly karstic area. In any karst region, development should proceed with an aquifer scale approach. Environmental studies should proceed using ecosystem style measurement criteria.

Using a Geodatabase Network to Determine Best Travel Routes through Jewel Cave

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The cave survey lines and stations shapefiles generated by CaveTools were imported to an ESRI ArcGIS feature dataset, and a geometric network was created in order to find best travel routes through Jewel Cave. The path taken from the elevator entrance to Camp Duh was determined to be 4.4 miles, and from the elevator to the end of current survey is 6.4 miles. Restrictions can be placed on the trace in order to avoid certain delicate speleothems or tight constrictions, and the resulting path can be exported as a new GIS layer. This could be a useful tool for cave rescue, as the most desirable path in a rescue situation is not always the shortest. The network is currently limited by the completeness of the cave survey, passage dimension data, and feature inventory, and will be improved upon as more data is collected and entered.

Walls 2D: Realistic Drawing and Morphing of Cave Walls and Passage Details and its Application to GIS

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Walls is a Windows-based program designed to help cave surveyors organize their data and prepare maps. Such programs typically adjust the data to compensate for inevitable errors, but Walls provides tools to identify gross errors in specific survey traverses,

While some programs also draw rough approximations of cave walls based on measured distances from survey stations, Walls 2D is a new component that makes Walls the first program to realistically draw cave passages and details. Scalable Vector Graphics file formats allow the use of

commercial drawing programs to create fully illustrated maps that Walls can adjust as the cave survey evolves, eliminating the need to fully or partially redraw maps. Sketches are morphed in appropriate ways, depending on their type of information, to reflect changes in the surrounding survey due to corrections and least-squares adjustments.

Certain Walls files can be exported to ArcView and ArcMap for GIS analysis and merged with track-logs and waypoints from Garmin GPS receivers to create complete, detailed georeferenced datasets. The Walls 2D output maps can potentially lead to automated and accurate calculation of cave areas, cave area to bedrock ratios, and analysis of certain hydrogeologic parameters.

POSTER DISPLAY

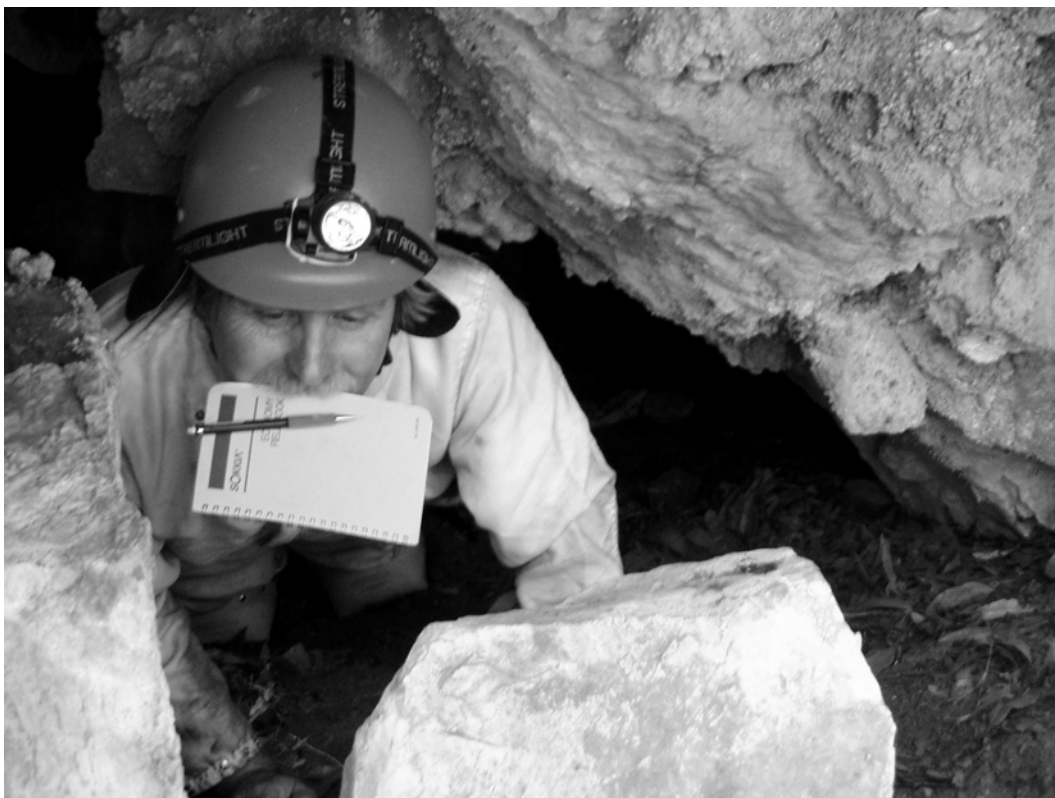
Karst Occurrence and Sinkhole GIS Coverages for Kentucky

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Growing interest and need for better karst maps for Kentucky has prompted the development of digital karst data. The Kentucky Geological Survey (through a published 30x60 arcminute karst groundwater basin map series in cooperation with the Kentucky Division of Water) and the Kentucky Speleological Survey (through a digital karst feature database) have independently collected and archived karst data for the past several years. Present publications based upon these data and improved by current digital geologic mapping techniques at the Kentucky Geological Survey include a Karst Occurrence map of Kentucky (depicting regions with potential for karst development) and a digital sinkhole coverage for Kentucky (consisting of karst related topographic depression polygons). These maps are an important foundation for further work and can provide an important resource for those working in karst prone areas of the state.



Scenes from the Pre-Convention Sketching Workshop held at Sequoia Kings Canyon National Park