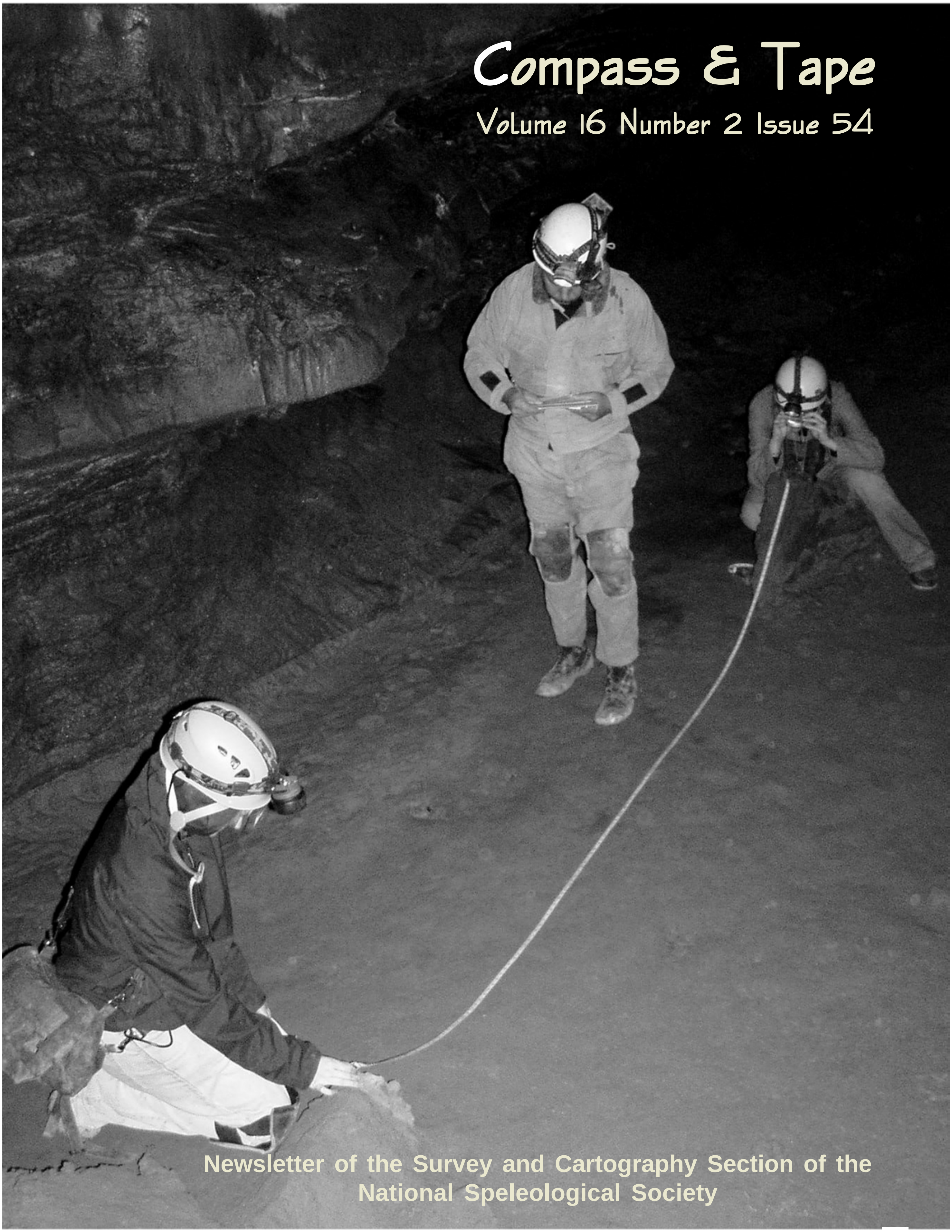
Compass & Tape

Volume 16 Number 2 Issue 54



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: Does 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 Treasuer.

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 primaly 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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INSIDE

From the Editor

The Survey and Carography Section is lucky to have a good crew of volunteers that keep the Section going with newsletters, mailings, website, NSS Convention activities and in taking care of all of the administrative tasks necessary to keep the Section solvent and running. Roger Bartholemew is one of those volunteers who has put a lot of his time and energy into seeing that the annual convention session is well organized and filled with good papers and presentations. Roger has served in this position since 1993 and has done an excellent job for the Section. He recently informs us that he is resigning from that position, one that he has held for 10 years. The Section expresses its regret at his resignation and also wants to collectively express our great appreciation for the work that Roger has put into the Survey and Cartography Section. He will be missed. Bob Hoke will be organizing the convention Session for 2004 in Michigan.

With Roger's resignation, the position of Vice Chair of the Survey and Cartography Section is vacant and we are actively looking for an energetic volunteer to fill that spot. The position has two responsibilities: the first is to back up the Chair in his/her absence during the annual meeting at Convention. The second and most important, is to organize and chair the Survey and Cartography Session at NSS Conventions. Roger will be a hard act to follow, but for those interested, please contact Bob Hoke at bob@hoke.net.

Front Cover: Bill Keith (Sketch), Micala Evans (Instruments), Jen Oblinger (Tape), Flint Ridge-Mammoth Cave System, photo by Pat Kambesis

Back Cover: Figure 1, from Magentic Storms, by Bob Thrun, this issue.

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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, grammer, 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 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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Errata

In the last issue of *Compass & Tape (Volume 16, No 1, #53)*, we omitted the last sentence and a few words in the NSS Convention abstracts from Jim Coke and Dale Green. Both abstracts follow in their entirety.

Regional Studies for Underwater Caves in Quintana Roo, Mexico

James G. Coke IV, P.O. Box 8663, The Woodlands, TX 77387, chac@lcc.net

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 SelectiveAvailability 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 talliedbetween 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. Additional software manages GPS data, while calibrating topographic maps and aerial photographs.

The Effects of Lava on Compass Readings

Dale Green, 4230 Sovereign Way, Salt Lake City, UT 84124, dajgreen@burgoyne.com

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) 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 magnetic field.

Cartoraphy Salon Correction for Omission:

The last issue of Compass and Tape (Volume 16, No. 2 Issue 53) omitted the following from the Cartographyic Salon results:

In the Apprentice Category, Mark Gee received an honorable mention (Green Ribbon) for his mapp of Half Hill Cave. Our apologies to Mark for the omission.

2004 NSS Convention, Marquette, Michigan
Survey and Cartography Section

CARTOGRAPHIC SALON

Exhibition of cave and karst-related maps

The 2004 Cartographic Salon will be held during the NSS Convention in Marquette, Michigan July 12-16, 2004. All entries can either be mailed to George Dasher (63 Valley Drive, Elkview, West Virginia 25071), postmarked no later than June 20th, 2004, or delivered to George in the Cartographic Salon exhibition area at the NSS Convention by noon Monday, July 12th, 2004.

There is no entry fee. Entries will be considered to have been donated to the NSS unless picked up by the cartographer on the afternoon of Friday, July 16th, 2004, or otherwise specified when submitted. If you wish your entry returned by mail, please provide $5 postage cost. If you want someone else to pick up your entry, please specify this in writing when the entry is submitted.

Entries must be representations of caves or karst-related features. Enter copies of maps rather than originals. There is no restriction on method of presentation and innovative techniques are encouraged. Entries will be divided into three categories (Apprentice, Experienced, and Master-Professional) at convention. Judging will occur at convention. Include a self-portrait preferably as a digital image [a slide is acceptable] if you wish it shown at the awards ceremony. Maps may be displayed in the salon, but not judged at the entrant's option. No cave map will be reproduced by the NSS without the owner's explicit permission, except for display during the convention.

More information about the Cartographic Salon (including judging criterica) can be found on the Surveying and Cartography Section's website at *http://caves.org/section/sacs/salons*. If you have any questions, please contact George at 304-965-1361(home) or wvcaver@juno.com.

CALL FOR PAPERS

This is a call for papers for the Survey and Cartography Session at the 2004 NSS Convention. The session is informal and provides a good way to tell other cave mappers what you are doing, and to discuss problems related to cave surveying, data management and manipulation, and cartography. Most cave surveyors have either devloped useful techniques that may benefit others or are encountering problems that someone else may have solved. In either case, an informal session presentation would be appropriate.

The session is informal and the audience is friendly. There are no requirements to provide fancy visual aids or to provide a written paper (other than an abstract to be included in the Convention Program.) Of course, the *Compass & Tape* editor would be glad to receive any written papers for publication.

Presentations can be on any topic related to any aspect of cave mapping, and the material presented can be for any level of mapping/cartographic experience.

Please send your abstracts either by email or snailmail to:

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(301) 725-5877
bob@hoke.net

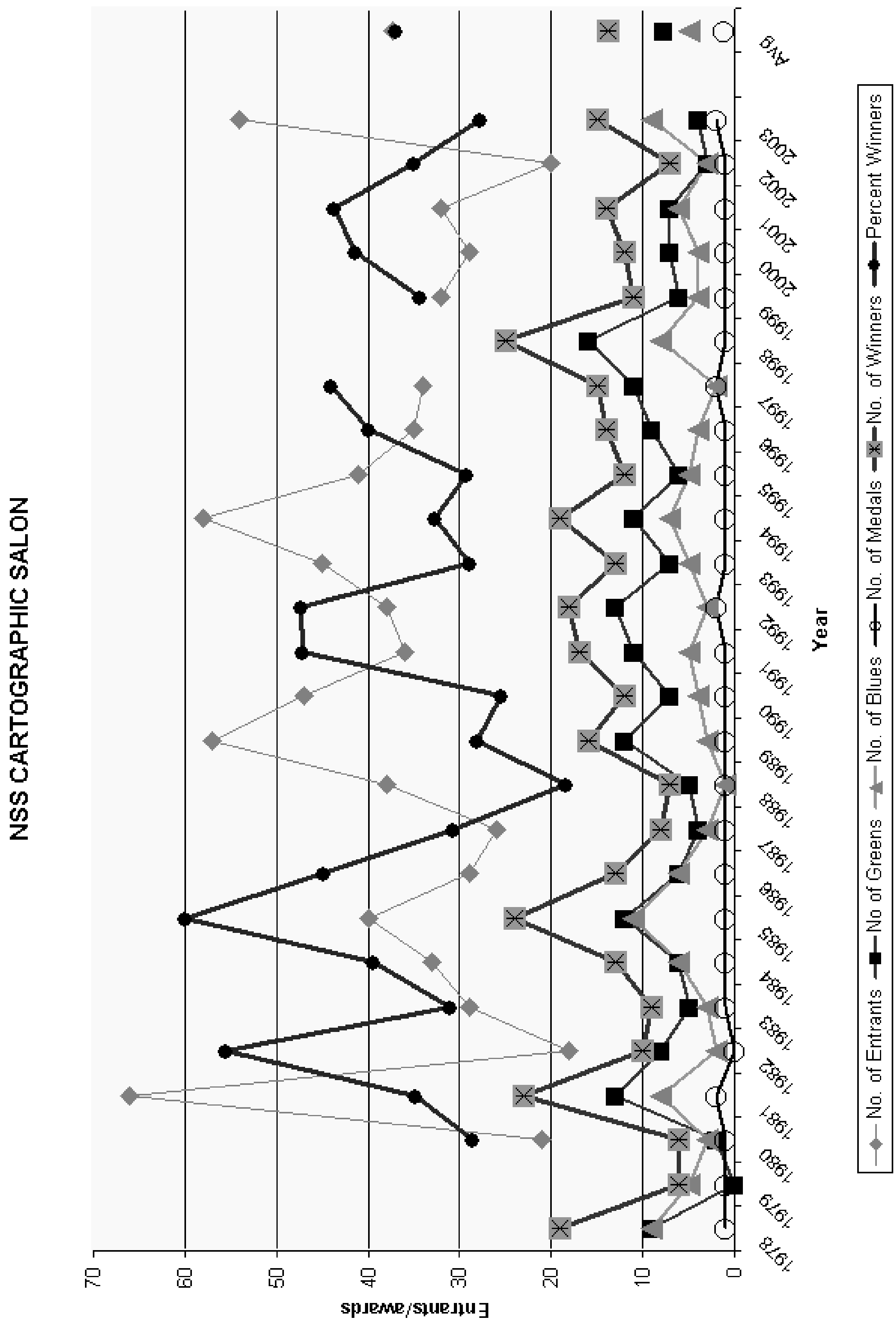
Cartographic Salon Awards Summary - 1978 - 2003

compiled by George Dasher

This is the official record of the cartographic salon awards since the inception of the Salon in 1978. Figure 1 is a graphical summary of the results listed below.

#	*Year*	*Place*	*Chairman*	*entrants*	*#HM*	*#MA*	*#Medals*	*%Winners*	*Medal winnders*
1	1978	New Braunfels, TX	Jan Knox	9	9	1	19		Orion Knox
2	1979	Pittsfield, MA	Art Palmer	0	5	1	6		Ward Fuller
3	1980	White Bear Lake, MN	Ernst Kastning		21	2	3	16 28.57	Peter Sprouse
4	1981	Bowling Green, KY	Ernst Kastning	66	13	8	2	23 34.85	Remy Wenger & Orion Knox
5	1982	Bend, OR	Ernst Kastning	18	8	2	0	10 55.56	no medal
6	1983	Elkins, WV	Ernst Kastning	29	5	3	1	9 31.03	Carol Vesely
7	1984	Sheridan, WY	Ernst Kastning	33	6	6	1	13 39.39	Carol Vesely
8	1985	Frankfort, KY	Ernst Kastning	40	12	11	1	24 60.00	John Ganter
9	1986	Tularosa, NM	Ernst Kastning	29	6	6	1	13 44.83	Peter Sprouse
10	1987	Sault Saint Marie, MI	Bill Nelson	26	4	3	1	8 30.77	George Dasher
11	1988	Hot Springs, SD	Bill Nelson	38	5	1	1	7 18.42	Mike Futrell
12	1989	Sewanee, TN	George Dasher	57	12	3	1	16 28.07	Tom Spina
13	1990	Yreka, CA	George Dasher	47	7	4	1	12 25.53	Pat Kambesis
14	1991	Cobleskill, NY	George Dasher	36	11	5	1	17 47.2	Hope Uhl
15	1992	Salem, IN	George Dasher	38	13	3	2	18 47.37	Mike Sutton, and Hope and Jeff Uhl
16	1993	Pendleton, OR	Ernst Kastning	45	7	5	1	13 28.8	George Dasher
17	1994	Barrackville, TX	George Dasher	58	11	7	1	19 32.76	Pat Kambesis
18	1995	Blacksburg, VA	George Dasher	41	6	5	1	12 29.27	Tom Spina
19	1996	Salida, CO	George Dasher	35	9	4	1	14 40.0	Bob Richards
20	1997	Sullivan, MO	George Dasher	34	11	2	2	15 44.12	Hazel Barton, and Bob Richards. and Kevin and Carlene Allred
21	1998	Sewanee, TN	Don Coons	16	8	1	25		Joel Despain and Greg Stock
22	1999	Flier, ID	Hazel Barton	32	6	4	1	11 34.38	Carlene Allred and Dave Love
23	2000	Elkins, WV	Rod Horrocks	29	7	4	1	12 41.38	John Ganter
24	2001	Mount Vernon, KY	Steve Reames	32	7	6	1	14 43.75	Carlene Allred and Dave Love
25	2002	Camden, ME	Steve Reams	20	3	3	1	7 35.00	Brent Aulenbach
26	2003	Pottersville, CA	Rod Horrocks	54	4	9	2	15 27.78	Peter Bosted and Hazel Barton
Averages				37.3	7.7	4.9	1.1	13.7 36.91	

H=Honorable mention (green ribbon), MA= Merit Award (blue ribbon)



NSS CARTOGRAPHIC SALON
Entrants/awards
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Avg
Year
No. of Entrants
No of Greens
No. of Blues
No. of Medals
No. of Winners
Percent Winners

Figure 1

Erik Halbert has been a caver in Sydney Speleological Society since 1965 and has been trip secretary for about the last 25 years! He has published many papers on cave climate but his long term interests are in the documentation and mapping of caves. Erik is currently working with the Wombeyan Caves and Blue Mountain Caves in New South Wales. He notes that he has used cave mapping programs since the 1980s and has always been interested in using existing software rather than writing his own. The author is very keen on the use of vector illustration in caves, especially with SVG and round tripping techniques. However, he also believes there is a place for an elegant, concise illustration program such as Mayura Draw.

Digital Cave Drawing with Mayura Draw

Erik Halbert

Introduction

There are many programs that reduce cave survey data and can prepare line plots. However, there is a lack of small low cost software that can convert line plots into finished maps, the sort that you can sit down and enjoy or present for publication. In searching for such a program I looked at many drawing programs including vector, raster and CAD types. There are free evaluation versions of all of these on the Net. I rapidly concluded that vector was the way to go. The Proyecto Espeleologico Purificacion (PEP) [(1)] group made the same decision. In their Cave Map Gallery section PEP state:

> 'Certainly, a vector-based file format of some sort will win out as the preferred means of presenting technical illustrations on the Internet.'

After using many programs I agree with this and would extend their view to the hard-copy preparation of maps. Burger [(2)] has the same view. Raster (paint) type programs have a variety of disadvantages and CAD programs have steep learning curves and tend to be non-intuitive and inflexible. Quite early I found Mayura Draw (Mayura) [(3)] and have been using it for several years. It is a shareware program. This paper presents some of my findings with its use as a fast and easy cave-drawing tool.

Discussion

My requirements for the cave-drawing drawing program were:

- PC based and Win compatible
- Import line plot data in vector format
- Import raster data such as scanned topographic maps or field sketches
- Low cost, fast and small in size
- Give needle sharp printed output
- Draw simple and complex cave maps in vector format
- Export PDF files

I prefer small applications that do one thing and do it well. Primarily I want a program that can handle the fairly simple cave maps that I need to produce. Mayura fits my criteria. It is a small but powerful drawing program for creating and editing vector images. It is not as versatile as XaraX, which is technically a better program for cavers. However, Mayura is shareware whereas XaraX costs about US$150. CorelDraw and the other giant vector programs such as Adobe Illustrator [(4)] and Deneba Canvas are more complex, more expensive and overkill for the average cavers needs.

Mayura is intended for engineers and scientists for creating technical illustrations. Graphic artists can also use it. The description on its web site at http://www.mayura.com is brief, saying…

> Using Mayura you can create illustrations composed of graphical shapes such as rectangles, ellipses, polygons [polylines], bezier curves, bitmapped images and text. Mayura has powerful tools for editing and transforming graphical shapes. All shapes including images and text can be scaled, rotated, skewed and reflected. Bezier curves can be edited by manipulating handles.
>
> Import: AI, WMF, GIF, JPEG, PNG, TIFF and BMP formats. Export: SVG, EPS, PS, AI, PDF, WMF, GIF, JPEG, PNG, BMP and TIFF formats. Mayura can export smooth, jaggy-free bitmaps.

This succinct description is reflected in the very sparse help file. The author is clearly a programmer and not a help file writer. This is good because he has produced a very elegant and compact programme. The current (November 2003) version 4.2 is 556KB in size.

Preparation of Maps

Mayura easily produces cave or area maps for publication. For simple caves such as Headbanger Cave (Figure 1) the drawing can be done without data input. For more complex cases the initial input to Mayura can be a line plot in vector format from a cave survey program such as *Compass* or *Walls*, and/or a raster scan (Figures 2 & 3) from a scanning device. Multiple scans can be inserted so that composite maps can be produced. Compass outputs a line plot in WMF form that Mayura can use.

Stages in preparation of map

- Open Mayura and choose a page size
- Insert scans or line plots if appropriate. Scans of 40MB have been used successfully.
- Draw the map using appropriate line widths, styles and map symbols.
- Put in symbols for scale, north arrows, and additional data boxes.
- Group all map objects.
- Orient the resultant map object to north and scale to paper size.
- Put in text.
- Insert the standard map symbols with boxes for author, title, equipment, grade et cetera.
- Group all objects to produce final map.
- Print map

These stages are common to nearly all mapping projects and follow the description that Burger (3) lays out. Most of the drawing is done with the Curve tool and the Polygon tool. The commands in Mayura are very fast and rapidly become second nature. I use 1.0pt line weights for wall plans and profiles, 0.75pt for structural details such as rocks, pool outlines et cetera and 0.5pt for floor detail. Line widths below 0.5pt should not be used because of printing and reproduction difficulties. I normally use an Arial font at sizes in the 7 to 10 point range.

The Curve tool is basic to Mayura map drawing. This does not have the intuitive feel of the Freehand tool of Xara X and CorelDraw. However, it promotes concise lines in terms of numbers of node points and actually can be an advantage in enabling the tracing of rounded lines such as contours to be carried out rapidly.

Particularly Useful Commands

Duplication: Ctrl D will duplicate any selected object or composite object. This can be single duplication or will repeat if you hold the keys down. This is very useful when you want to add a lot of symbol objects into a map. For example putting a lot of formation symbols or sand symbols or whatever. You can rapidly lay down a line of them and then move them into different places. It is also useful for filling areas with custom vector fills such as sand or gravel or rocks.

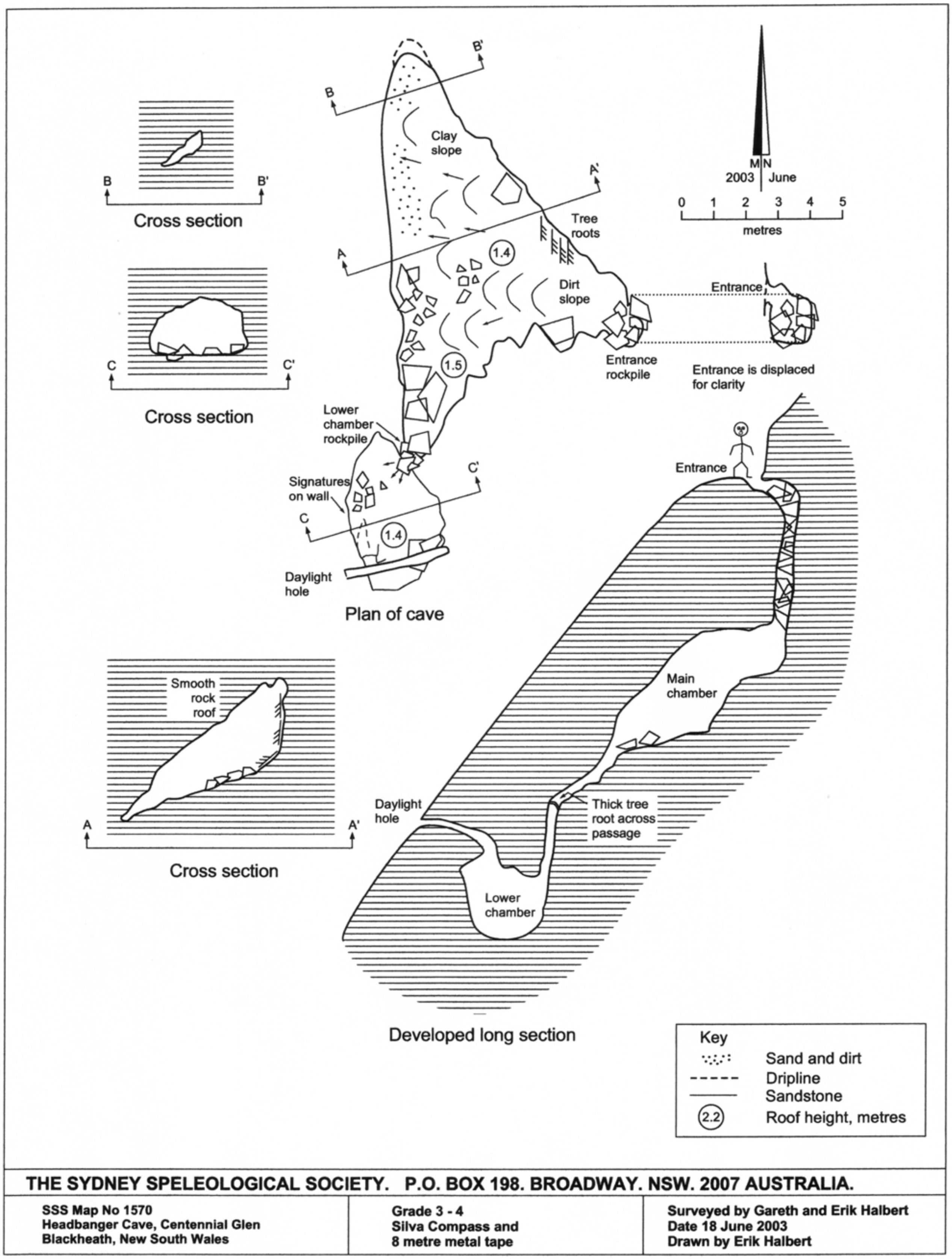
Fills: Mayura has vector fills that print well but you have to watch out if you are using PDF files. The Mayura PDF function does not export these fills. However, other PDF programs such as Jaws PDF (8) do. The fills include the IUS fill for water, a geological pattern for limestone, and a horizontal pattern suitable for sandstone. Fills such as a 20% black fill generally do export to PDF. However, these fills can lead to problems in later printing stages.

There are several ways to use fills. The simplest is to create a closed object and then fill it. This is useful for individual closed objects such as pools of water. However it is less easy to do this if you want to indicate a non-cave portion of limestone or sandstone, such as in a typical cross section. I put such fills in after the cave outline is complete. I copy the cave outline, resulting in a straight or freehand polyline. I close this polyline and fill it. I add nodes and adjust them to make the fill fit the area and then change the line to no line. Finally I place the fill behind the cave outline. This method is shown in the map of Virtually 21 Cave. With complex cave drawings this method needs care and practice.

Another method is to lay down a closed curve or shape with your fill and use this as a background (the background curve) on which to draw your cave. Draw the cave map as a closed curve (the cave curve) with white fill. This is very convenient for cross sections where the cave curve is wholly within the background and is used in Figure 1. The same technique can also be used for the major maps including plans. However, in this case the cave entrance(s) has to be considered. This is formed where the cave curve intersects the background curve and involves corner nodes at the intersection points. Again with a complex cave this method needs care, but pays dividends if later changes have to be made.

Nodes: Nodes are particularly useful for fine-tuning the shape of lines and wall detail. Curve fitting can be with the nodes or the control handles and nodes can be converted into corner nodes for further control. Practice helps here and perhaps a few of the many bezier tutorials on the Net.

Object Compound Path: This is very useful for drawing long and complex wall lines, especially when scal-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hole
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Entrance
Smooth
rock
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Main
chamber
Daylight
hole
Thick tree
root across
passage
Lower
chamber
Cross section
Developed long section
Key
Sand and dirt
Dripline
Sandstone
2.2
Roof height, metres
THE SYDNEY SPELEOLOGICAL SOCIETY. P.O. BOX 198. BROADWAY. NSW. 2007 AUSTRALIA.
SSS Map No 1570
Headbanger Cave, Centennial Glen
Blackheath, New South Wales
Grade 3 - 4
Silva Compass and
8 metre metal tape
Surveyed by Gareth and Erik Halbert
Date 18 June 2003
Drawn by Erik Halbert

Figure 1

ing or zooming is involved. Mayura cannot restart a line although there is a workaround for this.

Object Group and Ungroup: This is extremely fast. It enables individual sub-drawings within a drawing to be protected, and in the final stages it allows the entire drawing to be protected and moved around if necessary.

Object Snap: Object snap is particularly good when adding lines to other lines or walls. I use this command when I am drawing streams, stream branches and wall details. It works well with compound path commands.

Preview/Outline Mode: This command is extremely useful for sorting out overlapping objects and for allowing precise location of objects when using Nudge. In the final stages of the map this mode comes into its own as an aid to cleaning up and detecting forgotten objects that are essentially invisible but screw up the final map. For example it is common to have objects with a white fill and either no line colour or white colour. Also to have lines with white colour. These are invisible against the screen but increase the file size of the saved map. Sometimes these artifacts get well away from the map itself and are best detected by going to a custom page size of say 2000 x 2000, using Preview/Outline mode and then deleting any rubbish before returning to your default page size.

Undocumented Features and Workarounds

Line breaks: Mayura can remove nodes but does not break lines. This can be a problem when you want to add further passageway to a completed drawing. The simplest workaround is to use the polygon tool to draw a four-sided object over the section of line where you want the break to occur. Make this polygon white and no line and move it's corners until the line breaks beneath are perfect. The line and polygon can then be grouped and the new work attached to the "break" in matching line style.

Line and line styles: Mayura generates standard 0.25, 0.5, 0.75, 1, 2, 3, 4, and 5pt line widths. In most cases these are sufficient. However, different line widths such as 1.5 or 2.5 or 3.75pt can be imported as symbols in AI format and then kept as part of your map symbols file. Non-standard line widths and characters are readily transferred to existing lines, using the eyedropper tool.

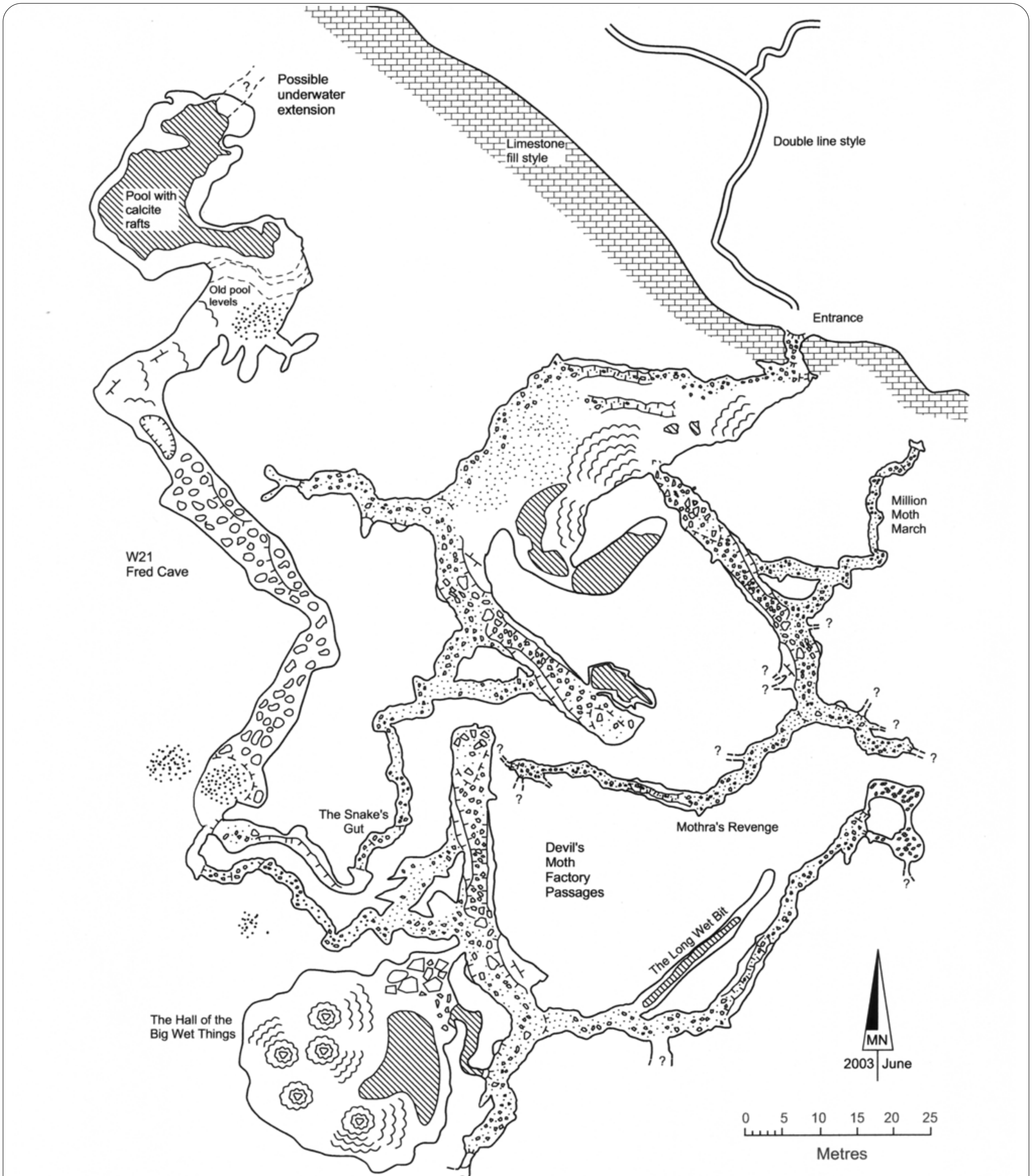
Mayura has five line styles but others can be made from them. For example, a long dashed line can be scaled down to produce a line with smaller dashes, or scaled upwards to produce a line with longer dashes. Such lines can then be treated as normal lines and lengthened etc as usual. Scaled lines print with the correct line style in Mayura but can revert to the original line style when saved and printed from a PDF file

Double line styles are useful for drawing roads and tracks but Mayura does not have this style. A workaround is as follows: Draw the track in black with an appropriate line width of say five points. Go into preview/outline mode. Duplicate the track. Make the duplicate line width two points and white. Superimpose the two tracks. Go out of preview/outline mode and you should have a double track. Group the two tracks. It is easier to do than to describe. :-) An example is shown in Figure 2. Complex tracks can be made in the same way after using the group command, before going into preview/outline mode. You can draw wide paths using wider non-standard line widths.

Nudge: Nudge is good for controlled close positioning of objects in the drawing and for moving grouped objects. To nudge an object you select it and then use the arrow keys. Used in conjunction with object snap and preview/outline mode you can achieve extremely precise location of objects.

Restarting lines: It is valuable to be able to restart a line after it has been finished. This usually occurs when the line goes off the edge of the monitor and you have to scale or move to continue. Mayura cannot formally restart lines but there is a satisfactory workaround. Zoom out, select the line, choose the end node that you want to continue and pull it straight to the end of the line to be traced. Sometimes you have to select the end node twice. Then zoom in, add appropriate nodes to the straight line section and pull each node to its desired position. This can be done quickly with the curve tool or the polygon tool and results in highly accurate tracing or drawing. As many nodes can be added as are needed.

Text matching: Mayura can handle TTF and T1 fonts and treats text entries as objects. Thus a piece of text can be scaled, rotated et cetera. However, when scaling is done it is not possible to find out the new font size. For example, generate some text at 20 point and scale the object to about half size. If you now pick the scaled object and try and check the font size you will find it says 20 point regardless of the actual new size. This contrasts with the behaviour of programs such as Corel or Xara X, which give you the new text size. A practical problem arises when you scale a Mayura drawing with text in it and then want to add more text to match the new text size. You cannot measure the new size so as to match it!! The workaround is to take a single piece of the scaled text, duplicate it and then edit the text. The new text will have the same characteristics as the old. Note that the eyedropper tool does not work with text objects.



THE SYDNEY SPELEOLOGICAL SOCIETY. P.O. BOX 198. BROADWAY. NSW. 2007 AUSTRALIA.		
SSS Map No... Cave Name Virtually 21 Blackheath, New South Wales	Grade 4 - 5 Digital Drawing and Tracing	Surveyed by ... Date ... Drawn by Erik Halbert

Figure 2

Map Symbols: It is useful to have cave map symbols on separate files and to insert these when needed. Mayura can open or insert AI files into a drawing. I have made symbols such as magnetic and true north arrows, compass scales, distance scales and cave plotting scales. These are kept as grouped objects and get copied and scaled as needed. I also have a standard data symbol with A4 outline and boxes with survey data including author, survey instruments, survey grade, dates of survey and drawing et cetera. Standard caving map symbols [5,6,7] are available from various countries.

Include a north arrow on your site plans and locations. Whenever I produce maps, I try to ensure that north is towards the top of the printed page. I always include a north arrow to make sure there is no confusion. For my own convenience, I have a single file, which contains every combination of scale bar, and north arrow I need plus other symbols that I commonly use on my site plans. Because these are digital vector objects, I can copy, edit and change them without any loss of print quality.

Dingbats and fonts are also valuable sources of symbols. For example, a useful symbol for sand may be obtained by using symbol (alt 0149) in the font Arial regular. This is used at 5 pt size and then duplicated. There are many freeware fonts of dingbats.

Tracing raster scans: It is straightforward to do a manual trace with the curve command in Mayura. I usually insert the bitmap and scale it to fit the page. Then I lock the map in place and use the curve tool to trace the contours etc. I use a contrasting line colour and a transparency of around 50% and make sure the scan is on the bottom. (Ie. At the back). Mayura can handle quite large files [8]. I recently scanned a section of a 1:25,000 topographic map location map for Beecroft Peninsula, NSW, and then inserted it into Mayura and manually traced it. The file size of the initial scanned topographic map was 7.8MB and the final Mayura map file was 49KB. A similar exercise with a Wombeyan Caves topographic scan started with a 42MB file. These were colour scans.

Figure 3 shows a map of a section of Upper Gap Creek at Wombeyan Caves, NSW prepared by tracing a small part of the Wombeyan Caves topographic scan. The underlying map was removed when tracing was complete and the positions of cave entrances were plotted.

Page Size: Simplify your life by setting up your Mayura page to match the final size of your cave map. This makes it significantly easier to position objects and avoids the problem of rescaling down if your map goes off the page. Choose a custom page size (in points) that matches your ultimate map. Mayura can preset A4, Letter and Legal page sizes and can custom set to a maximum page size of 5184 x 5184 points (1.83m x 1.83m). Ruler units can be set to centimetres, inches or points.

Examples of Cave Maps: Figure 1 shows a simple map produced from a cave survey of Headbanger Cave near Blackheath in the Blue Mountains of New South Wales (NSW), Australia. The cave cross sections use a horizontal line fill to indicate sandstone. The cave map MD file size is 123KB and the Jaws PDF is 70KB. The current format is A4.

Figure 2 shows a composite cave map of Virtually 21 Cave. This is a virtual cave used as a test bed for Mayura. It contains a double track line style, several line breaks with question marks in them, and a limestone fill style. The MD file is 658 KB and the PDF is 281 KB. The composite map uses the W21 Cave at Wombeyan, NSW, which I originally mapped in 1968 as well as parts of The Devil's Moth Factory map of Peter Sprouse on the PEP site. I inserted the Devils Moth Factory map into Mayura as an AI file before disassembling (object ungrouping) it and joining pieces to the 21 Cave map. The current format is A4.

Figure 3 shows cave digs and entrances on Upper Gap Creek at Wombeyan Caves, NSW. This was made using the tracing technique described earlier and the data were plotted directly onto the map using a compass. The compass dial can be seen in the figure. The MD file is 114 KB and the PDF is 73 KB. The current format is A4.

Scaling and Printing: Mayura produces needle sharp prints and PDFs. Both TTF and T1 fonts may be used and these also may be scaled. However, note that Mayura scales objects but does not scale line widths. This means that if a drawing is reduced in size the lines will become proportionately heavier and in extreme cases this can produce a 'heavy' print. To overcome this situation the drawing should be saved as a PDF or SVG file before rescaling and printing.

Conclusion

Mayura is a powerful vector drawing program suitable for drawing cave maps. Like all vector-drawing programs it needs practice before the operations become automatic. However, this is well worth doing. The program produces printed and electronic cave maps, which rival those of its much more complex and expensive siblings.

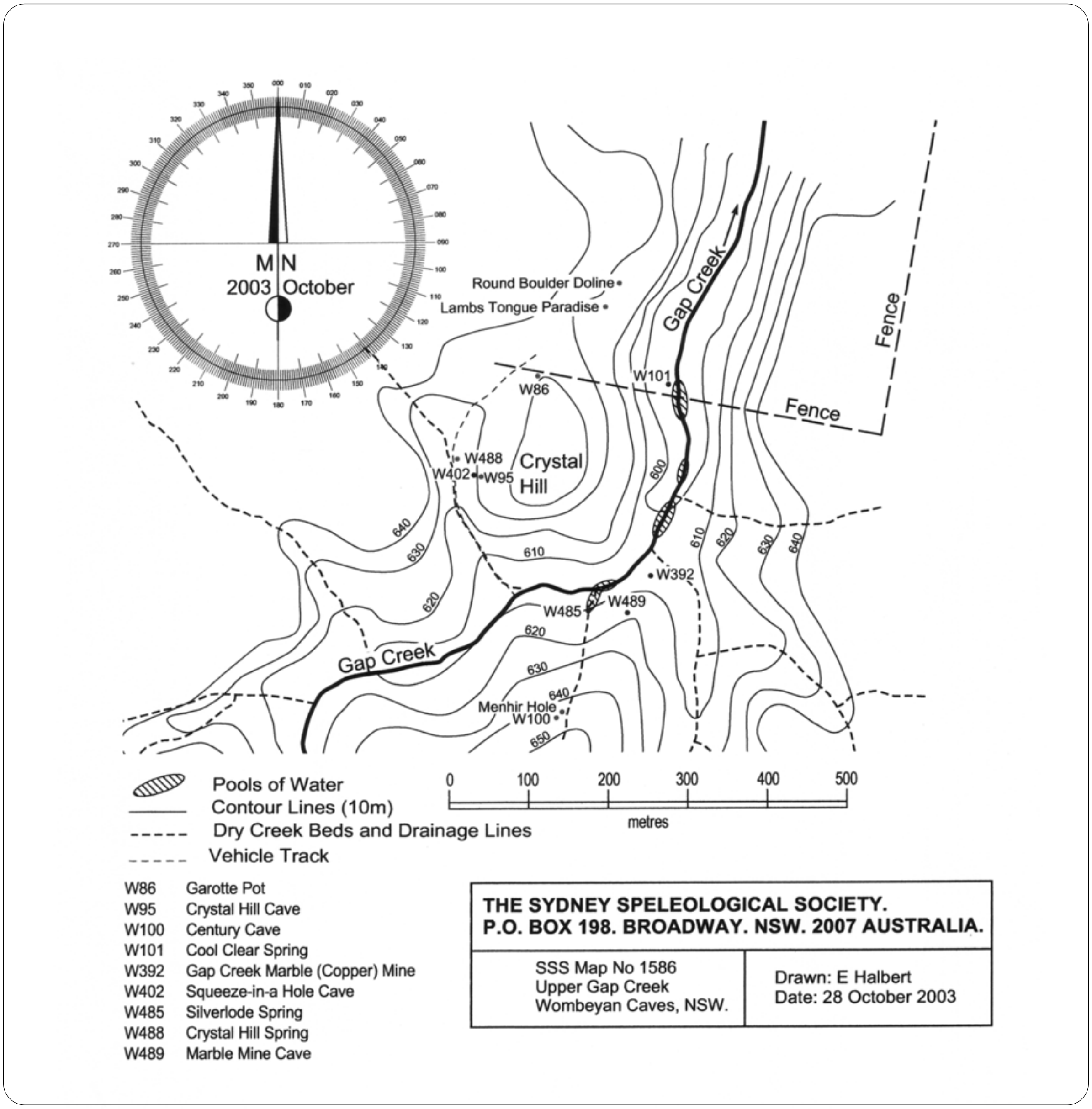


Figure 3

Acknowledgements

I would like to thank Peter Sprouse for permission to incorporate and publish parts of his Devil's Moth Factory map in my Virtually 21 map.

Notes and References

1 The Proyecto Espeleologico Purificacion (PEP) group *http://www.purificacion.org/*

2 Burger, Paul. 2000 'Creating Maps Using Canvas: Beginners Guide' *http://fountainware.com/compass/canvas.pdf*. This is a useful start to generating digital cave maps. It gives advice on line thicknesses and techniques.

3 Mayura can be downloaded from *www.mayura.com* as a zip file. The current version is 4.2 and the file size is 1.3MB, small enough to store on a floppy. When unzipped the file produces ten further files including the

program (556KB) and six MD files which are examples of the programs output. It is well worth taking some time to examine these since they show you how powerful the program is and you can disassemble them to see how various effects have been carried out. The 30-day trial version is still quite useable after the trial period expires. However, the export function is disabled. All other functions continue to work, including the save and print commands. For those who need PDF export capability there are freeware programs on the Net, which work with Mayura (see 8).

4 The Walls cave mapping program at *http://www.utexas.edu/depts/tnhc/.www/tss/WALLS/* suggests that SVG capability and layers will be an important future path for complex and very large cave systems. This combination will allow additions, corrections, and refinements in survey data to be incorporated in already drawn maps with no need to redraw wall and passage detail. This is known as SVG round tripping. Walls can do this with Adobe Illustrator 10 files at present. However, while Illustrator is the industry standard and the game to beat, it is expensive, immensely complex to learn and far more than the average caver needs. While Mayura does export SVG files it does not read them. For cave systems needing more flexibility than Mayura can supply, I would suggest Xara X and Corel Draw as the next steps.

5 Australian Speleological Federation Cave Survey and Map Standards are available at *http://www.caves.org.au/standards/mapping/stdsurv.html* and Cave Map Symbols are available at *http://www.caves.org.au/standards/mapping/print_stab-1n.htm*

6 The official UIS list of Cave Symbols is available at *http://www.karto.ethz.ch/neumann-cgi/cave_symbol.pl*

7 The PEP cave map symbols are available in AI, CDR and XAR formats at *http://www.purificacion.org/symbol.htm*

8 Like most vector drawing programs, Mayura saves maps to its proprietary format. This is an MD file and nothing else appears able to read these. However, it can export a variety of file types of which PDF and SVG are most useful. Adobe has made available its free PDF reader, (Acrobat Reader) at *http://www.adobe.com/products/acrobat/readstep2.html* and its SVG reader, (SVG Viewer) at *http://www.adobe.com/svg/main.html*. After the trial period Mayura will not export these file formats. However, there are many commercial and freeware programs, which will produce PDFs from Mayura. One of the former is Jaws PDF Creator from *www.jawspdf.com* recently available free on the cover CD of a computer magazine. One of the freeware ones is Win2PDF from Dane Prairie Systems at *www.daneprairie.com*. These install as print drivers and all you need do is select print from Mayura to create the PDF file.

The size of the PDF file depends on the set-up details of the PDF program. With Jaws PDF I routinely save to ‘Print’ quality. Headbanger Cave produced a PDF file of 70KB under these conditions. The same cave map saved to ‘Web’ quality produced a 68KB file and to ‘Press Ready’ quality produced a 344 KB file.

The situation with SVG is very fluid at present. There is an immense amount of work going on and the Adobe viewer site is a good place to start. SVG files can be individually tailored and unique fills and line styles can be set up. SVG files can also be handled with the freeware program SodiPodi. However, these are beyond the scope of this article.

The following article was re-printed from Compass Points Issue 28, September 2002.
Compass Points is the Journal of the BCRA Cave Surveying Group

Precision Surveys with the Brunton Compass

Art Palmer

When Art Palmer declared to the Cavers' Digest web site that he regularly obtains loop closure errors of the order of 0.05% using a Brunton compass for cave surveying, his claim was met with a certain amount of incredulity. In this article he outlines the methods he employs to attain this remarkable level of accuracy.

A year or two ago there was a brief flurry of correspondence on the Cavers' Digest Web site (USA) about the relative merits of Suunto versus Brunton compasses for cave surveying. The Brunton "pocket transit", for those not familiar with it, is one of the standard tools of the field geologist. It is hinged, with folding prongs in front and back for sighting (Figure 1 - front cover). A rear mirror provides an alternate way of sighting. Nearly everyone uses it hand-held, but unless it is mounted on a tripod its high cost and precision design are wasted. The discussion on Cavers' Digest quickly established that Suuntos were for real cavers and Bruntons were for effete snobs, or for mossbacks who refuse to change with the times.

But the Suunto has problems. It must be held close to the eye, so there is considerable chance for deflection by magnetically susceptible objects, such as parts of helmets and lamps, and even the pins in one's eyeglasses. It is difficult to ensure that the compass is situated directly over the survey point (or at the proper elevation during vertical shots). It is very difficult to sight at high angles. Finally, on the traditional model the numbers increase to the left, so inexperienced readers make frequent blunders. Still, they are ideal for the average cave survey.

I weighed in with a comment that Bruntons were superior to Suuntos if they were used correctly, and that I routinely get closure errors of about 0.05% in cave surveys - and the battle was on!

Several respondents found my claim to be incredible. Surely these results were a few lucky examples selected from many. How is it possible to obtain such low closure errors consistently, and under real cave conditions?

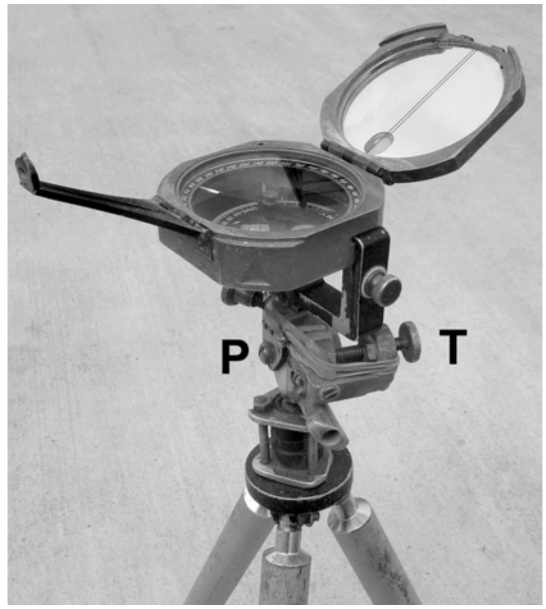


Figure 1: Brunton compass mounted on tripod and heavily modified pivot. T = tangent screw; P = pivot point for rotating compass 90 degrees to read inclination.

Like most passionately argued topics, this one is something of a non-issue. A good cave map shows what the cave is like and how to find where you are. Accuracy is usually a secondary issue. Besides, if you really want accuracy, use a theodolite. But we're concerned with fairly rapid surveying under typical cave conditions.

The following comments are an expansion of my final Cavers' Digest entry on the subject. Although they are specifically aimed at the Brunton compass, some apply to cave surveys of all kinds.

First, there are two general guidelines:

A. Minimise blunders by entrusting the compass readings only to those with extensive practice with the instrument. Each reading (even taped distances) should be made at least twice. Take your time, because the slowest person will usually be the sketcher. Avoid distractions - don't survey with people who are addicted to idle chatter!

B. The compass must be carefully calibrated. This is crucial for large projects where many different instruments are used, and/or when the survey extends over several years. Don't trust the magnetic declination specified on maps, because it is almost always out of date. Even such trusted sources as geological surveys usually rely on interpolation models that are only roughly accurate for any given site. Besides, most compasses have inherent internal errors, so it is necessary to calibrate each compass to true north individually. Establish a compass calibration course over the cave in question, and make sightings between fixed points in the calibration course before every survey trip. (It is also wise to re-check the readings afterward, to ensure that the compass has not become misaligned during the trip, and that there has been no short-term magnetic storm.) A reliable way to find the direction of true north is to make a star sighting with a theodolite and adjust for time and latitude. An adequate but less reliable method is to sight between two known points that are widely spaced on a topographic map. Subtract your compass reading from the actual direction on the map. This gives you a correction factor that must be added to each reading in your survey.

Beyond these obvious points, a few simple steps can reduce errors to about 0.05% with the Brunton. Except by chance, it is impossible to get the error much lower - 0.043% is my average over several dozen survey loops (0.011% standard deviation), and it is not going to improve, except once in a while due to dumb luck. The point is to prevent substantially higher errors.

To get this accuracy in a single shot, you would have to read the compass accurately to the nearest 0.03º. Good luck! Even measuring the distance to within 0.05% is difficult. But if the errors are random (i.e. not caused by systematic problems), they tend to cancel thanks to the “random walk” phenomenon. In each dimension (length, azimuth, and inclination) the readings ideally have a random scatter, and the error in each reading is just as likely to be too high as too low. Significant cancelling of errors will work only if there are many segments in a survey. A loop of only a few shots isn’t enough. A dozen will usually do. The longer the loop, the better the chance for a small closure error (error / loop distance), but also the greater the chance for a blunder.

Below are some hints on how to minimise survey error with the Brunton compass. Some are obvious, others are not. They will not guarantee the small loop-closure errors described here, but they will at least get you close.

1. Mount the compass on a tripod. This allows the needle to settle down to give stable readings, and also helps to keep the compass a safe distance from magnetic objects. With hand-held instruments, most people consistently position them off-centre relative to the station. This error is often systematic (non-random) and tends to accumulate rather than cancel. The tripod gets the compass reader up out of the mud, too, and requires fewer contortions. Brunton sells a non-magnetic tripod and a pivot for mounting the compass on it (see http://www.brunton.com). However the pivot has been recently re-designed so that it will not work. Trust me on this one. Mine fell apart after an attempt to make it work, so I modified it by adding a gizmo of acrylic plastic and aluminium (Figure 1). This includes a tangent screw, which allows smooth and easy sighting just by turning the screw (Figure 1). Of course, some passages just aren’t suited to Bruntons on tripods - river passages come to mind. However the tripod legs are retractable and can be adjusted to any ngle up to 90 degrees, so it is possible to use this technique in a surprising variety of passage types.

2. Use a small flashlight as a target for sighting. I have mounted mine on a second tripod, held in place with a swivelling head (Figure 2). This sounds like a lot of gear to carry into the cave, but the ease and precision of the resulting compass readings is well worth it. An additional benefit is that the person at the end of the tape is free to walk around and make measurements, rather than staying rooted to one spot while holding the light. Because all stations are “floating” above the floor, it is necessary to set permanent stations beneath the tripods by measuring downward with the tape. The permanent station on the floor needs a different name from the station at the tripod head.

3. Read the angles to the nearest 0.1º with a hand lens. Sharpening and extending the compass needle helps. Actual accuracy is probably no better than 0.2º, but it is surprising how consistently an experienced reader can read to 0.1º. Older Brunton models are better. The design has deteriorated in recent decades, and much of the original precision is gone. For example, induction damping makes the needle settle down faster, but the newly designed needle can’t be read so accurately without being modified.

4. Sighting with the Brunton can be a problem, because it is necessary to focus simultaneously on near objects (the compass sights) as well as on the distant

a target. Therefore, sight with the shadow method or some variant thereof. The simplest method is to align the shadow of the forward prong (cast by the target light) with the line on the mirror of the Brunton. This method, combined with the smooth action of the tangent screw, eliminates the stress of sighting the compass. For greater precision, I prefer to use the compass fully extended, and to sight between the two upraised end prongs. By holding the magnifying glass close enough that the rear sight is in focus, the image of the target light appears as a bright, moon-like disk with a virtual image of the forward sight imposed on it. I can't begin to explain the optics, but the result is that the images of the two sights can be brought together in a very clear and positive way. This method is also ideal for the vertical reading.

5. Alternate between foresights and backsights, shooting back to station 1 from station 2, forward from 2 to 3, back from 4 to 3, forward to 5, etc. This helps to cancel any calibration problems in the instrument. My two tripod mounts are the same size, so the target light and compass can be switched in case foresights and backsights are desired within the same survey leg. I rarely bother, and instead just repeat the basic readings from scratch and make sure they agree to the nearest 0.1° and 0.05 foot. I've never had any closure problems with this method, even in caves with commercial lighting and metal stairs. The tripod helps keep the compass at a safe distance.

Figure 5: Target light mounted on tripod with swiveling head. The filament stays in the same position regardless of tilt or swivel.

6. Keep the shots short – preferably less than 15 m. Otherwise tape sag and stretch are problems. Also, compass-related errors can be substantial on long shots.

7. Carefully sharpen the pivot on the Brunton so that the needle dances wildly when hand-held. On a tripod it should take about half a minute to come to rest. A sticky pivot is a big source of error, and it can be systematic if you tend to make the final rotation of the compass in the same direction each time. Tapping the tripod leg with a pencil helps prevent sticking needles, but this should not be necessary with a properly sharpened pivot.

8. Be careful to avoid parallax errors when reading the compass or inclinometer.

9. Check the calibration of your inclinometer. Sight between two points, both forward and backward, and take the average. To correct for maladjustments, subtract the forward reading from the average of the two readings, and add this correction factor to every reading. It's easier than trying to adjust your inclinometer to be perfect. Fussy people may want to repeat this calibration at a variety of angles, in case the inclinometer is off-centre. Thus the calibration factor may vary with the angle.

10. Correct for eccentricity (in the compass, that is). The pivots on most compasses are not perfectly centred, so foresights and backsights do not agree. My own Brunton has a maximum eccentricity error of 0.5°. Even the compasses on professional surveyors' transits are not immune.

If both foresight and backsight are made between each set of stations, and the two are averaged, the eccentricity errors cancel. But most people try to make the backsight match the foresight, unintentionally weighting the results in favour of the foresight. The two readings should be made independently and then averaged. If the compass is mounted on a tripod, it is very difficult to get reliable backsights unless two tripods are used (see item 2). Even with two tripods, it takes a great deal of patience to switch the compass and target lights to allow backsights. The added time and fatigue tend to counteract the benefits of using the tripod in the first place. It is easier to check for accuracy by making repeated measurements, rather than with combined fore/backsights between each pair of stations (see item 5), but if you do, it is critical to adjust for eccentricity.

To determine compass eccentricity, design a calibration course with radiating lines every 15º or so from a central point, using a theodolite. From the central point, shoot to each outer point with the compass and determine the discrepancy between the actual readings and the correct values. Corrections can be made from a simple graph of the results, or they can be made by fitting the discrepancies to a sine function. This and other calibrations can be made with a simple computer routine, and with a bit of luck it can be inserted into your favourite survey software.

Below are two examples of closure error using this method. Each used the two-tripod technique, leapfrogging between stations with alternate foresights and backsights. No reverse shots were made between any given pair of stations.

A few years ago I was asked to run a base-line survey through Virgin Cave, New Mexico, by the U.S. Forest Service. The route was highly irregular, involving lots of steep angles, hanging out over deep space, etc. It included a complex loop of 550 m that took three days to complete. Total X-Y-Z closure error (with eccentricity correction) was 0.71 ft, or 0.04%. This is a typical result.

The Compass course at the National Speleological Society convention of 1998 offered more comfortable conditions. My wife and I ran a tripod-mounted Brunton survey with an uncorrected closure error of 0.137% - the overall winner for that and any other year. This included the total X-Y-Z error. (We also required the least time of any party.) However, to level the playing field, we purposely did not account for eccentricity. Corrected for eccentricity, the closure error dropped to 0.017%! A bit of luck there.

I mention these two examples specifically because they were computed under supervision. Computing the Virgin Cave survey was a bit sweaty because there were Park Service and Forest Service staff looking over my shoulder as I entered the data. You can't count on luck when you have a single chance to get it right.

Many cave surveyors will scoff at this list of suggestions. They are welcome to, because cave-survey accuracy is not a burning issue. But for the base-line surveys through major passages, this method is quite accurate, fast, and comfortable. Still, when the mud and water start to rise, I'll reach for my Suunto.

Magnetic Storms

by Bob Thrun

This is a followup of my article Hourly Variation of Magnetic Declination that appeared in *Compass Points No. 18* and *Compass & Tape No. 43*. In that article I mentioned that the declination, the difference between true north ant magnetic north, is affected by sunspot activity. At the end of October 2003, there were two large solar flares that caused geomagnetic storms on Earth. The first of these was reported in the newspapers to be the largest in many years and it was followed by another large storm about a day later. I decided to see how much a large magnetic storm could affect a compass reading.

I got hourly means of magnetic declination measured at the Hartland magnetic observatory from a *British Geological Survey website*, *http://www.geomag.bgs.ac.uk/gifs/hourly_means.html* . These data are in a more convenient form than I could get from an American observatory. These data are plotted in Figure 1 (see back cover) Note that October 31 goes from 31.0 to 32.0 . The IGRF magnetic model predicts a declination of –4.243 degrees at the site.

Figure 1. Magnetic Storms - October - November 2003 by Bob Thrun