

# Caves.com

## The Magazine

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Photo by

*Chris Andersen*



The  
Drysuit



# Caves.com

Exploring the "hard" side of Cave Digging, Cave Exploration and emerging techniques and equipment.

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Most of the activities depicted herein carry a significant risk of personal injury or death. Caving, cavedigging and other underground activities are inherently dangerous. The owners of Caves.com do not recommend that anyone participate in these activities unless they are experts or have trained with qualified and knowledgeable individuals.

## The USIA Drysuit

By Mark Passerby



Pictured here is the new USIA <http://www.usia.com> caving drysuit. The next page features a background photo of the suit being worn in-cave in Zicafoose Blowhole.

I have used the suit now on multiple trips including two into a cave called Bobcat Blowhole(1200' entrance crawl) and it has performed remarkably well and kept me dry and comfortable. Even in complete water crawls and wet muddy areas the suit has kept me completely dry and comfortable.

**CONSTRUCTION:** the entire suit including integrated booties is made from a tri-ply fabric. The outer surface(black) is a thin fincordura with the middle membrane made from a breathable waterproof fabric.

**High Wear Areas(Red on suit):** These areas on the suit are covered with 1000 Cordura and are exceptionally resistant to wear, much like what can be expected from a heavy duty standard cavesuit. The knees have a double velcro pocket that allows for easy insertion of foam for knee protection.



**Boots:** Each leg additionally has a complete cuff that pulls firmly over the top of the wellies to protect against debris entering the boot. An integrated bootie insures that the feet stay warm and dry.

**Waterproof Zippers:** The suit is a front entry suit made possible by a sturdy waterproof zipper that crosses the chest and further protected by an additional zipper and mud flap that effectively keeps the waterproof zipper protected from mud and debris clogging.

**Seals:** Seals are provided on both wrists and at the neck to insure that water stays out of the suit.

Contact USIA at 800-247-8070 for pricing info.



Cover Photo: Self photographed drain in Mammoth Cave shot by Chris Anderson



# CaveDiggers.com

The End is Our Beginning

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# Cave Maps by XaraX

by Tom Lounsbury



## Introduction

Digital cave maps are now easier to draw than ever before. It appears almost everyone has a computer these days and there are a myriad of graphic programs available everywhere. I feel that Xara X is the cave cartographers dream come true. Xara X must be the most powerful, lowest costing, most intuitive, graphics drawing program out there with results far easier to obtain than with the other big programs. It brings the reluctant pen and ink cartographer into the digital age for a mere \$150.00 and a copy of this free tutorial. That is chicken feed pricing for a graphics program this powerful, capable of doing anything a cave cartographer can imagine. Lets compare Freehand, Canvas, Illustrator and

Corel Draw at \$400 to \$500 and never mind the CAD programs at thousands of dollars and a mind-boggling learning curve. Xara X will always win hands down. I have literally seen beginners drawing great maps in less than an hour of hands on training. Xara X is quite simply the best value vector graphics drawing package you can use at this time. I will attempt to provide yet another option for digital cave cartography through my own personal experience and methods using Xara X. Even though there are several methods that can be used to achieve the same result I will make all attempts to keep it as basic as I can. Xara X has an incredible help file. Xara X's help contains hundreds of pages of information. If you need a hand using the program or want to know how to do something, try searching the help. Not only are there pages describing what all the parts of the program do, there are overviews, pages explaining terms, step-by-step procedures to help you get your work done and many examples. You will also find that many pages have buttons you can click to run movies. To open the help, just press F1 on your keyboard.

### Export formats:

- .BMP Windows Bitmap
- .DCX DCX
- .PCX PCX
- .GIF CompuServe GIF
- .GIF Animated GIF files
- .JPG JPEG
- .PCT PICT
- .PNG PNG
- .RAS Sun Raster
- .TGA TrueVision TARGA
- .TIF TIFF (RGB)
- .WPG Word Perfect Group (256 color)

### Import formats:

- .301 Brook Trout
- .BMP Windows Bitmap
- .CAL CALS (2 color)
- .CUT Halo CUT (256 color)
- .DCX DCX
- .GIF CompuServe Graphics Interchange Format (see Importing transparent bitmap files)
- .GX2 Storyboard
- .ICA IOCA (2 color)
- .ICO Microsoft Windows Icon (16 color)
- .IFF Amiga IFF
- .IMG IMG (16 color)
- .JPG JPEG
- .KFX KOFAX
- .LV LaserView (2 color)
- .MAC MacPaint (2 color)
- .MSP Microsoft Paint (2 color)
- .PCD PhotoCD
- .PCT PICT
- .PCX PCX Paintbrush
- .PBM UNIX monochrome
- .PGM UNIX grayscale
- .PNG PNG (see Importing transparent bitmap files)
- .PPM UNIX color (up to 24 bit)
- .PSD Photoshop
- .RAS Sun Raster
- .TGA TrueVision TARGA
- .TIF TIFF (RGB, RGBA with alpha-channel transparency & CMYK)
- .WPG Word Perfect Group (256 color)

- .XBM X Windows (2 color)
- .XPM X Windows (256 color)
- .PAL PaintShop Pro Palette
- .ACT Adobe Color Table
- .ACO Adobe Color Swatch

### EPS Export Formats:

- .AI Illustrator EPS
- .EPS Illustrator EPS
- .EPS ArtWorks EPS
- .EPS Xara X EPS

### Other Export Formats:

- .XAR CorelXARA
- .WEB Xara Webster files
- .WMF Windows Metafile
- .EMF Enhanced Windows Metafile
- .CMX Corel CMX 5 & 6
- .HTM Image map
- .SWF Macromedia Flash

### EPS Import Formats

- .AI Illustrator EPS
- .EPS Illustrator EPS
- .EPS CorelDRAW 3 & 4 EPS
- .EPS FreeHand 3.0 EPS
- .EPS ArtWorks EPS

Xara X cannot import Photoshop EPS files; use PSD files instead.

### Other Import Formats

- .XAR CorelXARA (1.1 and 1.5)
- .ART Xara Studio
- .WEB Xara Webster files
- .AFF Acorn Draw
- .CDR CorelDRAW (3,4 & 5) (see Importing CDR files)
- .CDT CorelDRAW Template
- .CMX Corel CMX 5 & 6 (see Importing CMX files)
- .DRW Acorn Draw
- .HTM Graphics on HTML pages
- .WMF Windows Metafile
- .WIX For internal use by Xara

### Palette Import Formats

- .CPL CorelDRAW Palette
- .PAL CorelDRAW Palette
- .PAL Microsoft Palette

### Bitmap Export Formats

- .BMP Windows Bitmap (see Creating BMP files)
- .DCX DCX (see Creating DCX files)
- .PCX PCX (see Creating PCX files)
- .GIF CompuServe GIF (see Creating GIF files)
- .GIF Animated GIF files (see Creating animated GIF files)
- .JPG JPEG (see Creating JPEG files)
- .PCT PICT (see Creating PICT files)
- .PNG PNG (see Creating PNG files)
- .RAS Sun Raster (see Creating RAS files)
- .TGA TrueVision TARGA (see Creating TARGA files)
- .TIF TIFF (RGB) (see Creating TIFF files)
- .WPG Word Perfect Group (256 color) (see Creating WPG files)

### EPS Export Formats

- .AI Illustrator EPS
- .EPS Illustrator EPS
- .EPS ArtWorks EPS
- .EPS Xara X EPS (see Xara X EPS Overview)

### Other Export Formats

- .XAR CorelXARA
- .WEB Xara Webster files (see Creating Xara WEB files)
- .WMF Windows Metafile (see Exporting Windows Metafiles)
- .EMF Enhanced Windows Metafile (see Exporting Windows Metafiles)
- .CMX Corel CMX 5 & 6 (see Exporting CMX files)
- .HTM Image map
- .SWF Macromedia Flash (see Exporting Macromedia Flash files)
- .WIX For internal use by Xara

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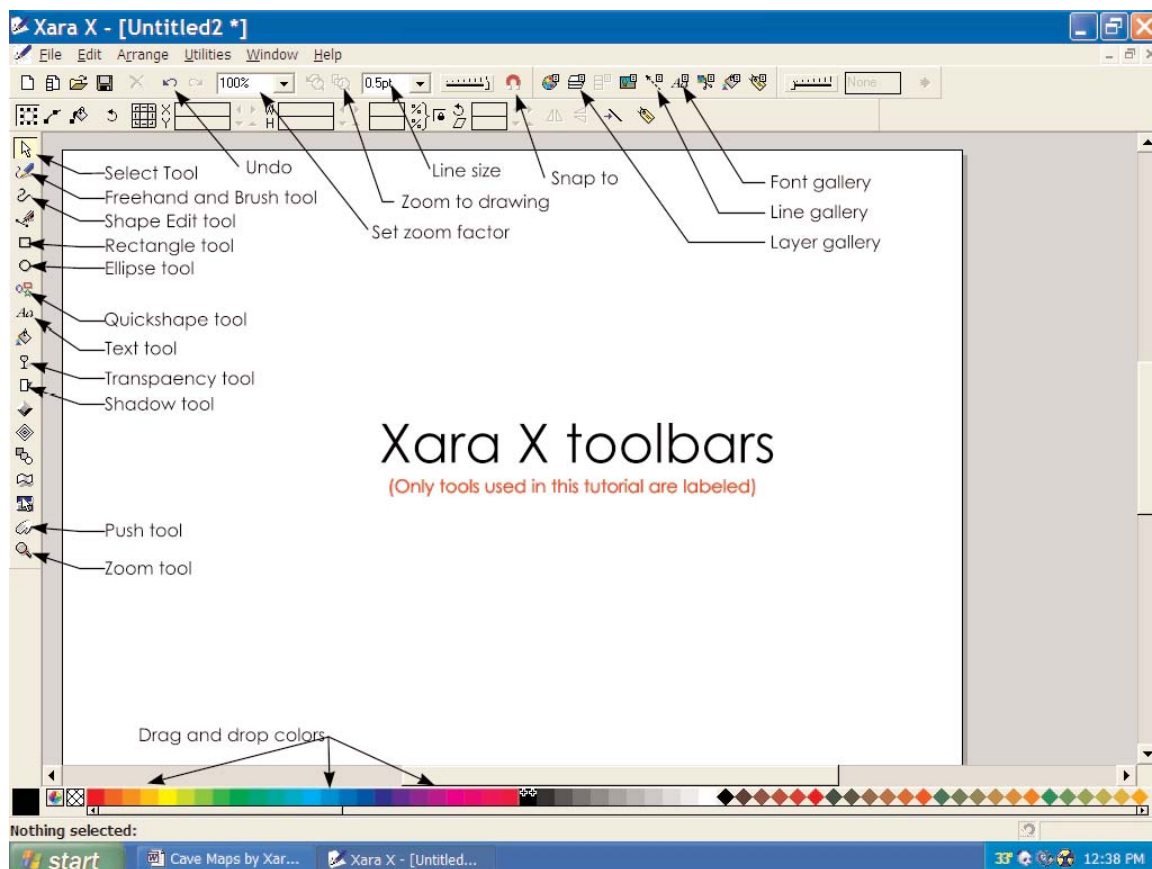
XARA X has many enhancements and improvements over its predecessor, CorelXARA. The pioneers of real-time on screen anti-aliasing and transparency now bring you a whole collection of new features to make Xara X an irresistible choice for the creation of vector graphics of any sort. <http://www.xara.com/products/xarax/>

You can find lots more information on Xara X, including tutorials, examples, discussions, hints, tips and featured artists at the XaraXone web-site. <http://www.xaraxone.com/>

## Getting started

I must only assume you are operating Microsoft Windows 98 or better and have Xara X installed. A free 30 day trial version is available at <http://www.xara.com/products/xarax/>. You also must have the ability to export the line plot out of your favorite data reduction program as a common graphic form such as a bitmap, metafile, jpeg, tiff etc. I have recently changed from Compass to Winkarst because I like its ability to morph the sketches to the line plot. This now alleviates the need to actually draw the working map. The working map is created for you as you add your scanned sketches. When I am satisfied with all the sketches and the surveying is done I export the map (bitmap) into a folder on my desktop being sure the scale bar is also exported with it being line plot or morphed map. Don't worry Xara X handles gigantic bitmaps with ease and redraw (when the bitmap is rescaled, skewed, or moved) is almost instantaneous.

## Xara X tools used to create cave maps



### Layers

Xara X does permit multi-layer drawing so it is easy to produce highly variable maps just by turning on and off corresponding layers of your drawing to achieve the desired result. I use to import my scanned sketches into Xara then manipulate the sketch to fit my accurate line plot that I generated and exported from Compass. I now use Winkarst because of the saved step in creating a working map. Winkarst uses your scanned sketches to build a working map of the cave as you go. Morphing the sketch around the line plot so you don't have to move and rotate each separate sketch by hand. However you import your drawings, Xara X provides several ways to manipulate the drawings to achieve the last step in drawing your final map.

### Tools

Each tool in Xara X has many attributes that can be manipulated in several ways. I will attempt to describe the actions and steps needed to gain the necessary results rather than fill this tutorial with many unnecessary screenshots or impertinent information. There are always several different methods that can be used to achieve the same results your looking for. I am attempting to keep it simple so the most basic methods will be described.

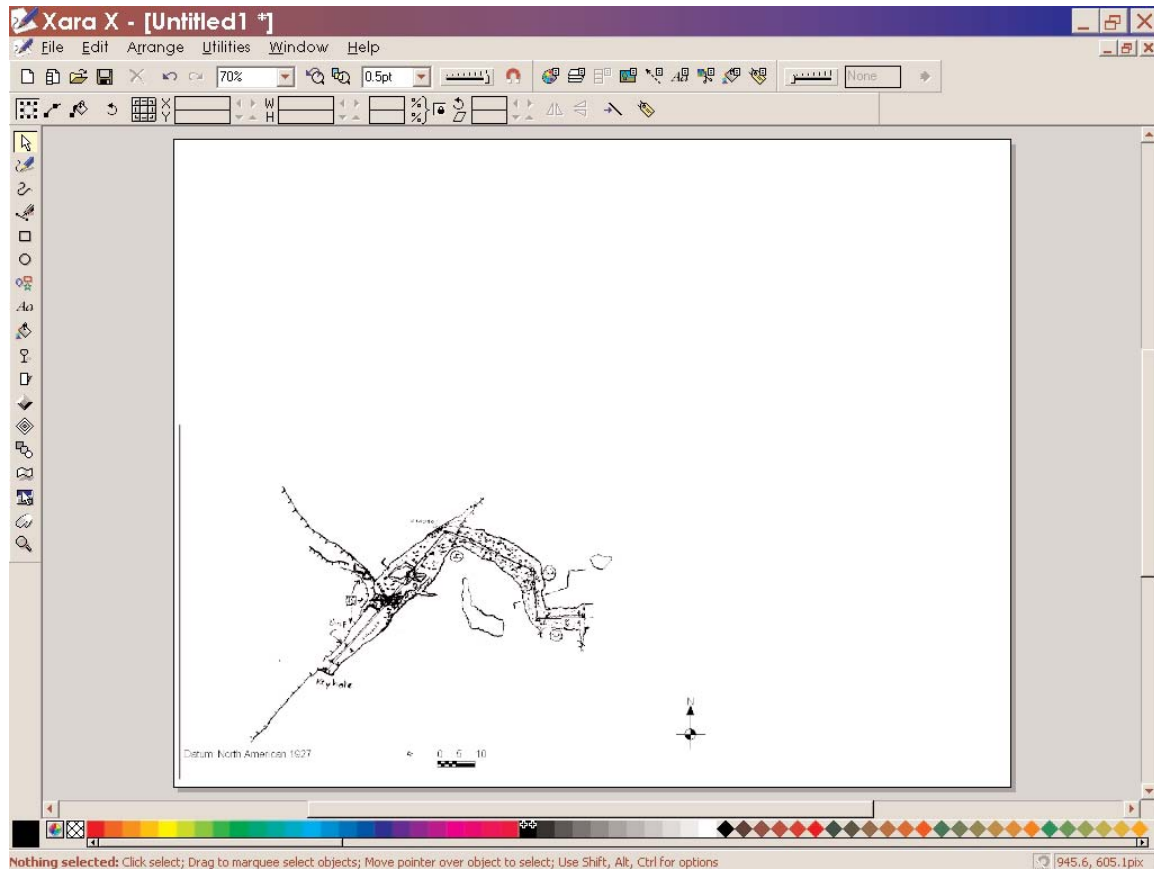
*Continued on Page 6*

## Lets Begin

Open Xara X. You will see the default page is 800 x 600 pixels. This is where you will need to set the page parameters you will want to use for your new drawing. Go to **Utilities/Options** and choose the **units tab**. Change the units from Pixels to Inches hit **apply**. Then choose the **Page tab**. Here you can specify any page size you need to get the map on one page at the desired scale. Hit **apply** then **OK**. These settings can be changed later if you discover you need a larger page to accommodate your drawing.

## Winkarst method:

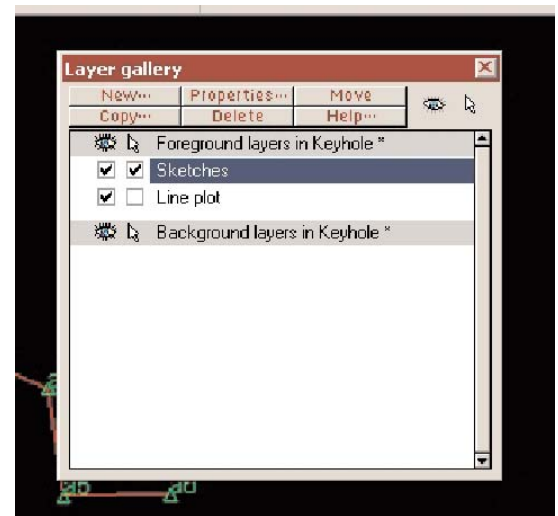
Next you will need to Import your saved bitmap of the line plot and/or the finished working map into this drawing. Go to **File/Import** locate your file and double click to finish the import process. Your file should be visible now as in the following screenshot. If you are not using Winkarst and only have the ability to export the line plot then you can assemble and align each individual sketch as well. This is much more time consuming and can be prone to error if your not very careful. This is called the Compass Method that is detailed below.



If you can't see the imported bitmap you are to close on the magnification scale. To change to full page view simply set your **Zoom factor** to **Page** or **Drawing** whichever display you prefer.

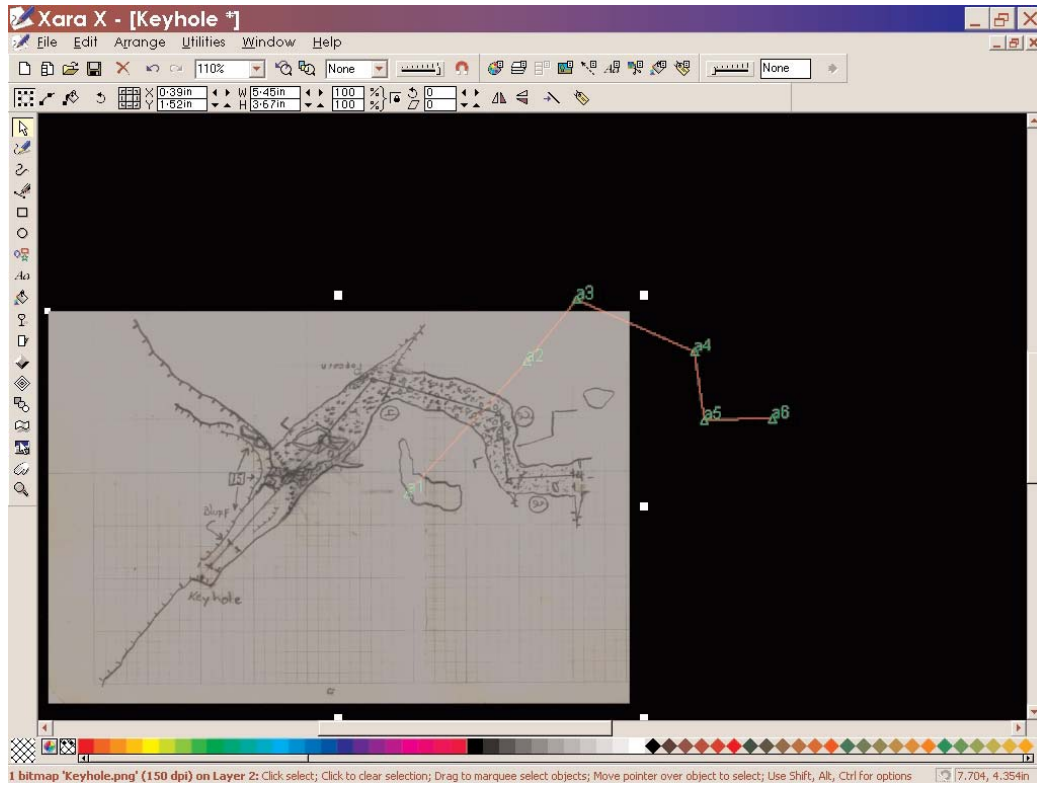
## Compass method:

Begin by scanning all of your sketches as bitmaps and storing them in a separate folder labeled Sketches. Create the line plot in Compass being sure to adjust your scale and export it into a folder as well. Next import the line plot. Next open the **Layer gallery**. You will see that there is only one layer called Layer one. Go to the **Properties tab** and rename this layer **Line plot**. Next create a **New** layer called **sketches** it will default to the layer just above the Line Plot layer. you should see two layers in the layer gallery. The two check boxes next to each layer indicates weather the layer is visible or editable. The following screenshot shows the line plot layer visible but not editable and the sketch layer both visible and editable with this being the active layer. This is needed to easily edit the different aspects of your map without affecting other features. Complex cave maps can appear quit busy when all layers are visible so turning off separate layers is vital in sorting out all the different features of a cave map.

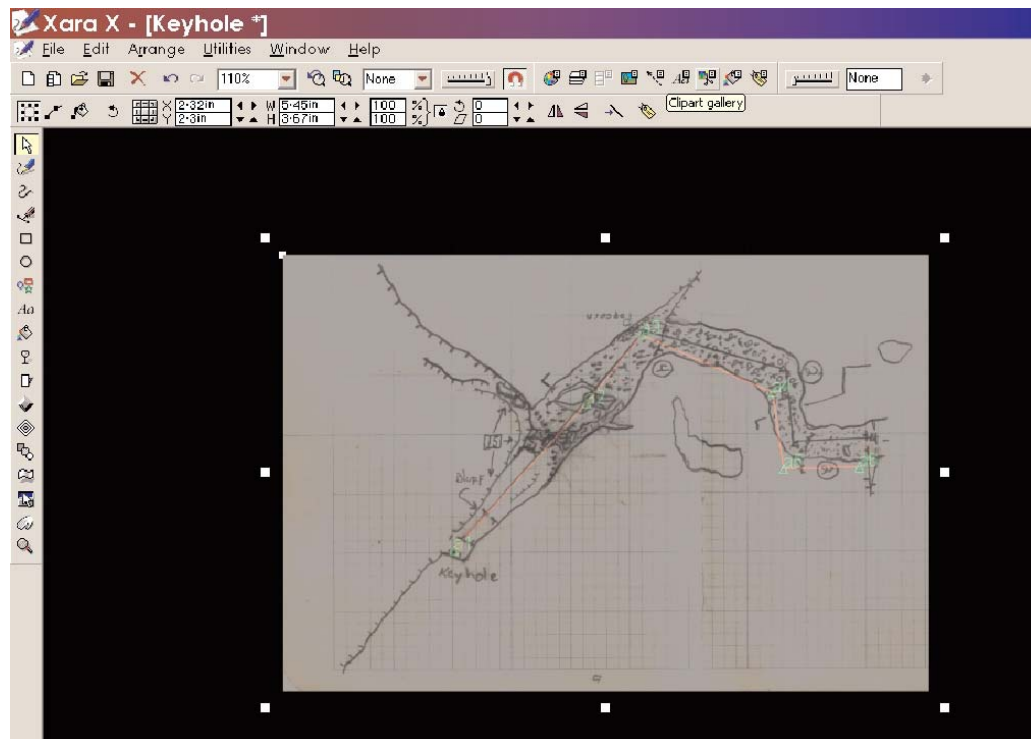


*Continued on Page 7*

Now import the first sketch being sure that the sketch layer is highlighted. Your sketch should now be visible. The line plot should not be visible where it is covered by your first sketch. To make the line plot visible use the **Select tool** and select the sketch you just imported. Now select the **Transparency Tool**. Adjust the transparency of the sketch until your satisfied with the transparency level you can affectively see the line plot under your sketch as in the following screen shot by moving the transparency scale bar (visible when the transparency tool is selected) to around 50%. You will do this to each sketch as you need them.



Next you will need to turn off editable on the line plot layer so you can move the sketch over the line plot without moving the line plot. This is done by un-checking the edit box on the line plot layer in the layer gallery. Start with the first sketch and place it where it belongs in accordance with the line plot by putting the cursor on the first station hold down on the left button of your mouse and drag it to align the first station on the sketch with the first station of the line plot release the mouse button and repeat where necessary.

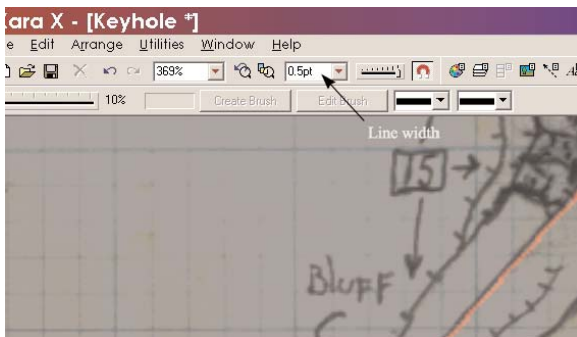


Continued on Page 8

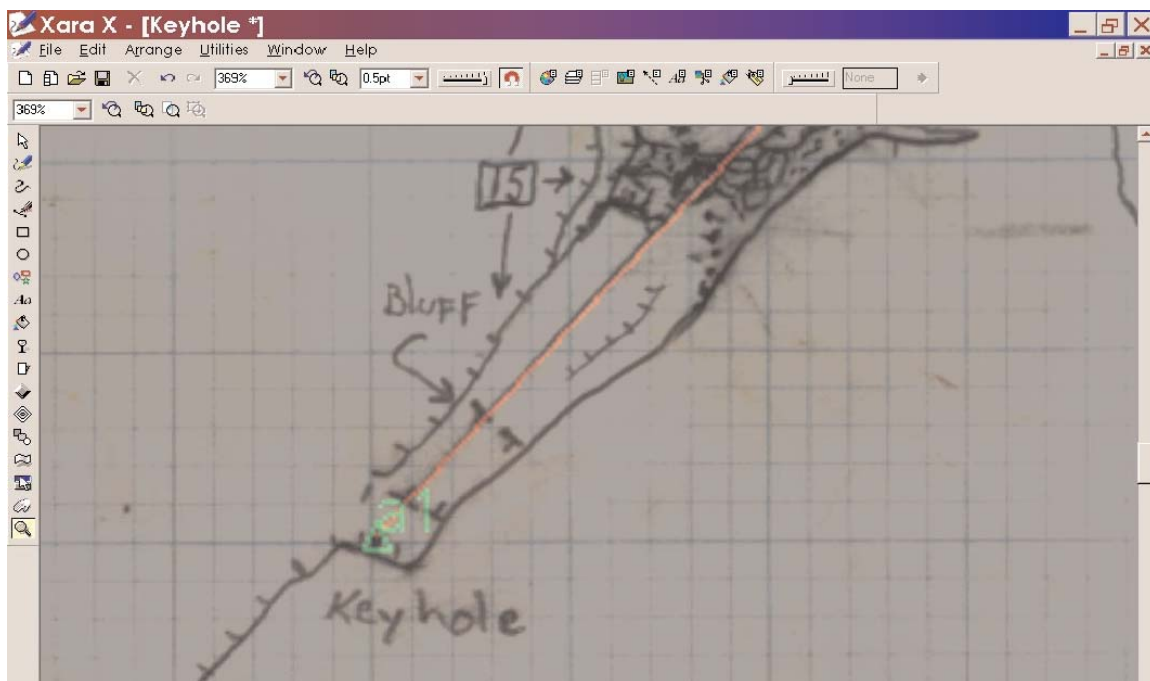
You may notice some discrepancies in the sketch as you align the sketch over the line plot. This is normal because it isn't a perfect world and no sketch is as perfect as a reduced line plot.

### Drawing walls:

Begin your drawing by adding a new layer to the **Layer gallery** called **Walls**. Turn off the other layers but leave them visible. Highlight the walls layer and make sure both boxes are checked and the Sketch layer and the line plot layer have only the visible box checked and the editable box un-checked. Close the layer gallery. Next choose the **Zoom tool** and select an area of the drawing by holding down the left



mouse button and drag it down to create a rectangle of the area you will need to zoom in on. Release the left mouse button and you should be much closer now and ready to trace the walls for the first few stations. Start by selecting the **Freehand and Brush tool**. Set the **Freehand smoothing bar** down to almost 10%. The smoothing bar is directly above the select toolbox and becomes visible when you select the freehand and brush tool. Xara X has the ability to smooth out your lines to alleviate the harsh jagged line you would draw using a mouse. I like my walls rough because cave walls are rarely perfectly smooth. Now trace the wall for the first 2 stations. If the line thickness needs changed simply change it by selecting it, then change it using the **Line width bar** or changing its properties in the line gallery. I use 2.0 for walls.



Do not draw all the walls yet. You will need to move the sketch around to align the corresponding stations that were not perfectly aligned to begin with. To rotate a sketch just click on the sketch twice to bring up the rotation handles. You may also move the pivot point so you can rotate the sketch around any point that you choose by holding down the left mouse button while you drag the rotation point. I normally rotate my sketch around a survey station, draw some wall, then repeat as necessary until I am satisfied the sketch walls have been adequately traced.

### Creating the interior:

As you begin the next step in filling in your map I would like to stress here how critical it is to keep the details of the cave separated using the **Layer gallery**. Normally I begin by adding the floor detail to the map by creating a new layer called **Floor**. I found out through a few trial and error maps that its better to put this layer beneath the walls layer. Just drag it down in the layer gallery. This layer sits just below your walls layer. This is so any feature on the floor will not sit atop the walls lines. Sometimes using a brush stroke can cause certain features like cobbles to spill a little onto the wrong line. This is a good time to make sure the visibility is on and the editable is off for your walls layer.

### Sand:



Sand floors are a monotonous part of cave floors and there can at times be a great deal of it in our Ozark caves. To create sand use the same procedure you did for Cobbles only reduce the size of your cobbles to look like sand grains. Or do what I do. I select the **Text tool** and create three or four periods from the default font which is of course is new times roman. I then place them in a random appearance and group them with the **selector tool**

selection rectangle. Again choose the **freehand and Brush tool**. Select the **Create brush**

*Continued on Page 9*



**stroke** button. Name this new brush stroke **Sand**. To paint your floors takes a little practice so it does not give the appearance of uniformity. Again overlapping and random patterns give the best results for this and do not let your imagination hold you back. It is easy to get your map to look its best when the sand is not exactly evenly distributed with even blank places to represent almost featureless floors, not in my maps.

### Clay and silt:

This was a daunting task to do in the old days of pen and ink. To get the pattern just right is as easy as drawing a line. Using the **Freehand and Brush tool** select a dashed line pattern out of the line gallery and its size to .25 with a round cap. Next hold down the Alt key while dragging out horizontal line that is the proper length to cover the width of your area. Next using the **Selector tool** select the line and duplicate it by holding down the Ctrl key and D. You will notice that Xara has duplicated your line and it now sits just below and to the right of your first line. If this space (duplication distance) is to large you can change it by going to **Utilities/Options** and on the **General tab** at the bottom is the duplication distance. It can be set to any desirable distance to fit your individual needs. Try subtracting half of the value to start until you have achieved the results you want. Next you will need to trim them so each line fits into its designated position. Using the **Selector tool** select a line and grab one of the middle resize handles on either end of the line. Resize the line by dragging the handle to lengthen or shorten the length of the line to fit your needs.

### Cobbles:

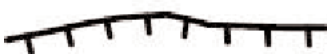


Again cobbled floors can be tedious work if done by hand. Xara allows this feature to be drawn as a brush stroke. Start by selecting the **Freehand and Brush tool** and set a line width of .25 and a pure white fill. The fill color bar is located across the bottom of your Xara screen. Left click it, the "+" means it is now going to fill anything drawn by this line that closes will be a filled shape. Next draw three different cobble shapes close together. When you see the + sign when your close to completing the circle it means when you release the left mouse button Xara closes the circle for you. Now we group these three cobbles together by selecting our selector tool and dragging a selection rectangle around the three of them. When done correctly all three shapes will show a handle, letting you know that it has been selected. Next go to **Arrange/Group**. Now select the **Freehand and Brush tool**. Choose **Create Brush button**. Name this brush stroke **Cobbles**. Now each time you want to add an area of cobbles or small breakdown piles you can select this brush and literally watch Xara paint the cobbles for you. I normally use a small tight figure 8 pattern to get it just right. This brush doesn't take a lot of imagination to realize the possibilities of brush strokes are limitless. We use brush strokes for a great deal of drawing in Xara X. All brush strokes are fully editable and various attributes can be added or subtracted through the use of the **Edit brush** button. Play with it when you want to experiment a little for various attributes can be spectacular and beyond your expectations. Xara X is made for cavers.



### Breakdown:

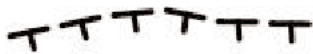
Drawing breakdown using Xara X is a breeze. Any shape you can dream up is a great piece of breakdown. Look at a rock, notice its shades and shadow lines. Make all attempts to stray away from standardizing your breakdown. Its random variations are what gives depth to your map. Start by drawing a closed shape. Choose your **Freehand and Brush tool**. Next choose line size of .50 and fill color of 20% black. Next hold down the Ctrl key and D to make an instant duplicate. Using your selector tool grab a corner resize handle and shrink the second shape just a little. Now drag a 10% black fill box up to this shape. It's now filled with a slightly lighter shade of gray. Next move it so it sits on top of your first shape. It should look like a slab of breakdown. Now we group these two shapes together by dragging a selection rectangle with the **Selector tool** around them both and then going to **Arrange/Group** now resize, skew, or rotate as needed. Next we will apply shadows to just the biggest blocks and the shadow parameters. This can quickly get out of hand if you're a new Xara user. Its just to easy. Xara will apply a shadow to any shape you select. First we will select a block of breakdown. Next choose the **Shadow tool**. When selected a new attribute bar becomes visible. Just above the Selector tool is 4 choices of shadows. Choose **Wall Shadow**. Next you will see a shadow has been applied to you breakdown block. Now you can use the **shadow blur bar** to sharpen the shadows edge if you like. Also by clicking on the shadow you can drag adjust the shadow to any angle of observation. Shadows should not necessarily be applied to small breakdown. It can greatly affect your printers ability to print at a reduced scale and besides it just makes little sense. Big breakdown benefits from shadows, small breakdown does not.



### Floor ledges:

Ledges on floors look there very best when it looks uniform and almost machine made. Xara gives the cartographer an easy means of drawing floor ledges with again the use of a brush stroke. Begin by selecting your **Freehand and Brush tool**. Select a line size of .50 and in the line gallery choose Round Cap. Hold down the Alt key on your keyboard and draw a short horizontal line. Repeat the process only this time drawing a short vertical line. By holding down the Alt key Xara draws a perfectly straight line instead of a freehand line. Now select the **selector tool** and select the short vertical line. Move this line so it intersects the horizontal line it the middle with one end of the vertical line forming a T. Next go to **Arrange/Group**. Selecting the **Freehand and Brush tool** click on the create Brush button and name this brush stroke **Hatch**. Next, draw the floor ledge where you need it on your map. It may not look correct at first so using the Edit brush button it is easy to rotate the hatches so they all line up perfectly. You may also need to adjust the spacing so each hatch just touches its neighbor hatch forming a great looking floor ledge. Hit save when your satisfied and from now on all of your floor ledges will be perfect with little to no editing needed.

*Continued on Page 10*



### Ceiling ledges:

Ceiling ledges are as easy to create as floor ledges and in fact the **Hatch** brush you created earlier for floor ledges is a simple means of creating ceiling ledges as well. Start by selecting the **Freehand and Brush tool**. Next locate the hatch brush in the drop down box located next to the edit brush button. Draw a length of floor ledge then select the Edit Brush button. On the spacing tab you can simply move the slider bar and Xara will separate each hatch for you. When you obtain the desired look click on **save as new**. Name this brush Ceiling. Keep in mind everything associated with a ceiling feature should be separated to its own layer. Open the layer gallery to add and rearrange layers as needed.



### H2O:

Color is a wonderful thing if it is not too distracting. I now use a transparent blue along with a flat transparent line fill to create nice water features. I have seen several different methods on Xara for creating pools and streams and I will describe a few ways to create the three samples here. The nice thing also is once you have a design you like just save it as a Xara template. It becomes available for all your future drawings and can be manipulated with ease to accommo-

date  
any

#### • Pools:



I generally start by selecting the **Freehand and Brush tool**. I apply a blue fill color and a line size of .25. I draw the shape of the pool in accordance with the sketch I am tracing. Next I duplicate it (Ctrl, D) and apply a no color fill that I drag up onto the duplicated shape. It will now be colorless. Using the **Freehand and Brush tool** draw a .25 horizontal line just above the pool shape and then duplicate it with the Ctrl +D keys on your keyboard. If the lines are not close enough to achieve the desired result you can change the duplication distance with **Utilities/Options**. On the general tab at the bottom is the duplication distance

parameter settings. These two numbers can be changed to increase or decrease the amount of distance between duplicated objects. I normally use a 5pix separation for the desired affect.

#### • Streams:



Streams are quit common features that in some cases will be the focal point of the map because of its distinct look or size. It can be easy to draw the stream if you want to use the standard symbols for water. I however like to see the stream looking as if flow was occurring. To do this is as easy as it comes. I start by selecting the **Freehand and brush tool**. I next choose the **VanGogh** brush and make it blue by selecting this color on the color bar at the bottom of the screen. I begin to paint the stream changing the line thickness to best suit the need of the drawing. Small streams can be a line

size of 4 or 5 while large rivers could get as big as 10 or 12. It is your scale of the drawing plus the size of the stream that will best dictate the line size for your needs. Next select the **Transparency tool** and adjust the shade so the rocks can be seen beneath your water if you so desire.

desired affect your looking for in later drawings.



### Flowstone:

Nothing more than a letter C, Flowstone that often coats the walls or floors is drawn by using the **Text tool** to create the letter C using a font that has a wide opening and is symmetrically shaped. I use Century Gothic. Next create a brush called Flowstone and drag out a length of C's so you can begin to edit the brush so it is configured to your own personal taste. Next you will want to activate the brush edit button by selecting the **Freehand and Brush tool** and here is where the final shape of your new brush is acquired. By first selecting the **Rotation** tab you can drag the rotation bar until all the letter C's are lined up side by side. Then on the **Spacing** tab again slide the spacing bar over to get the letters to just touch. When your satisfied dick save and close the edit box and begin to draw your flowstone.

### Exterior:



The exterior parts of a cave map normally include the crosssections, profiles, offsets, and any pertinent technical information about the cave including the scale and north arrow. Cross sections are as simple as tracing the sketch cross-section then re-size it for the correct scale. To add the cross-section locator lines is a matter of holding down the Alt key while drawing a straight line using the **Freehand and Brush tool**. Drawing this line directly across the section of cave you wish to portray you can easily add another directional leg by holding the tip of the pen on a handle when you see the + its ready to resume drawing and will attach another leg directly onto your existing line. When you have the length you need just release the left mouse button. Now you will need to remove the section of line that intersects the cave passage and remove all of it contained between the cave walls. This requires you to actually make two

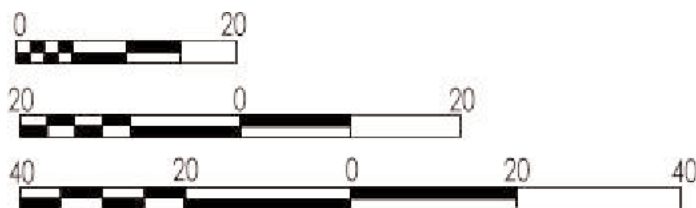
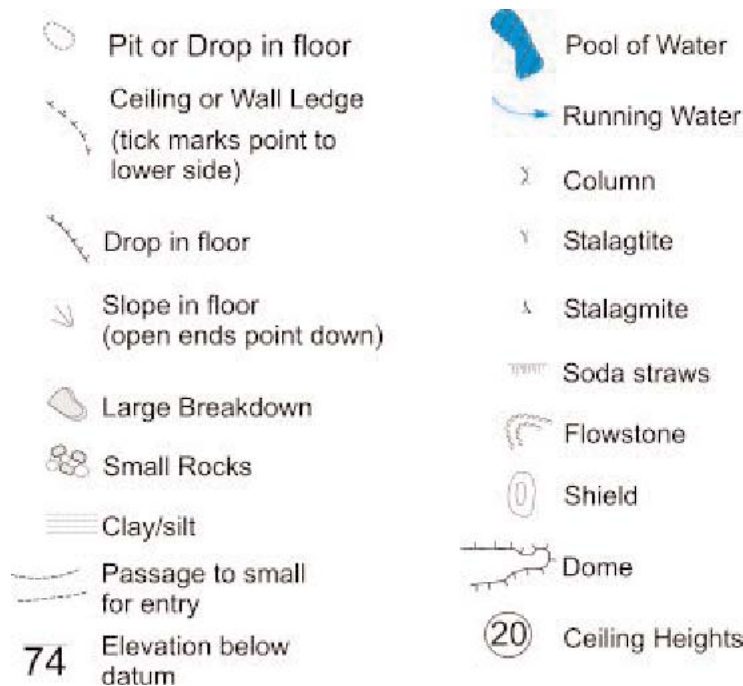
cuts in your line. The process is this simple. With your **selector tool** select the line and then select the **Shape editor tool**. Use this tool to cut your line by moving the cursor over the line and when it changes into the arrowhead click on the line. You will notice a small red box attached to the line where you placed

*Continued on Page 11*



the cursor. Now move the cursor up to the Break at Points button. Click it to make the cut. Now repeat this process for the other wall. Once you have completed that cut now using the **Selector tool** select the line between your two cuts. Now delete it using the delete button in Xara or the delete key on your keyboard. You can add arrowheads to the end of your lines if you like by selecting one of many in the **Line Gallery**. Just open it up and open the folder labeled Arrowheads. If it points the wrong direction just flip it using the flip buttons located directly above your drawing on the first bar.

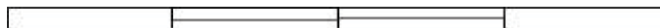
### Some Xara Examples:



### Scale:

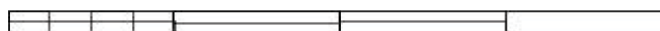
Lets see how easy it is to create a very nice scale that will need to be saved as a template so you never need to recreate it. Just import it and rescale it according to the scale imported on your line plot. To begin this project you will select the **Rectangle tool** and drag out a long thin rectangle. To make it easy just copy it length to the scale length on your line plot. Next make a duplication by using Ctrl + D on the keyboard. Now at the top of the drawing along the

first bar you should see a closed padlock button that is depressed. Click on this button to open the padlock. This unlocks the drawing aspect ratio setting so we can physically enter the ratio of reduction you desire. Its simple mathematics. To divide the length of the original rectangle so we have 4 equal parts we need to reduce the duplicate by 50% in length and 25% in width on the first set. Use Ctrl + D to create 3 more duplicates. Now making sure the Snap to Objects button (the red magnet) is active and using the **Selector tool** drag one smaller rectangle



and align it on top of the first. When you see the mini-magnet show up for your cursor it means they are aligned and snapped to the next object. Your drawing should look like this.

Next we need to duplicate the smaller boxes and again reduce there size to 25% in length and 50% in height this will again give us a total of



4 equal size 1/4 scale of the parent box. Again we are ready to select one of the 4 smaller boxes and align them with the box directly below. Now your scale should look like this.

Next the black squares. Using the selector tool select on of the squares you want to color black. Once selected left click on the solid black fill color at the bottom of the Xara



Continued on Page 12

screen. It is now filled with black. Repeat the process for each additional box you want filled. It should now look something like this.

Next we add the numbers by selecting the Text tool and then choosing the font and the font size. Anywhere drag your mouse to the right to create the text line. Type your numbers you need for the scale. ( 0, 10, 20, 40, etc.) now using the selector tool drag each number where you

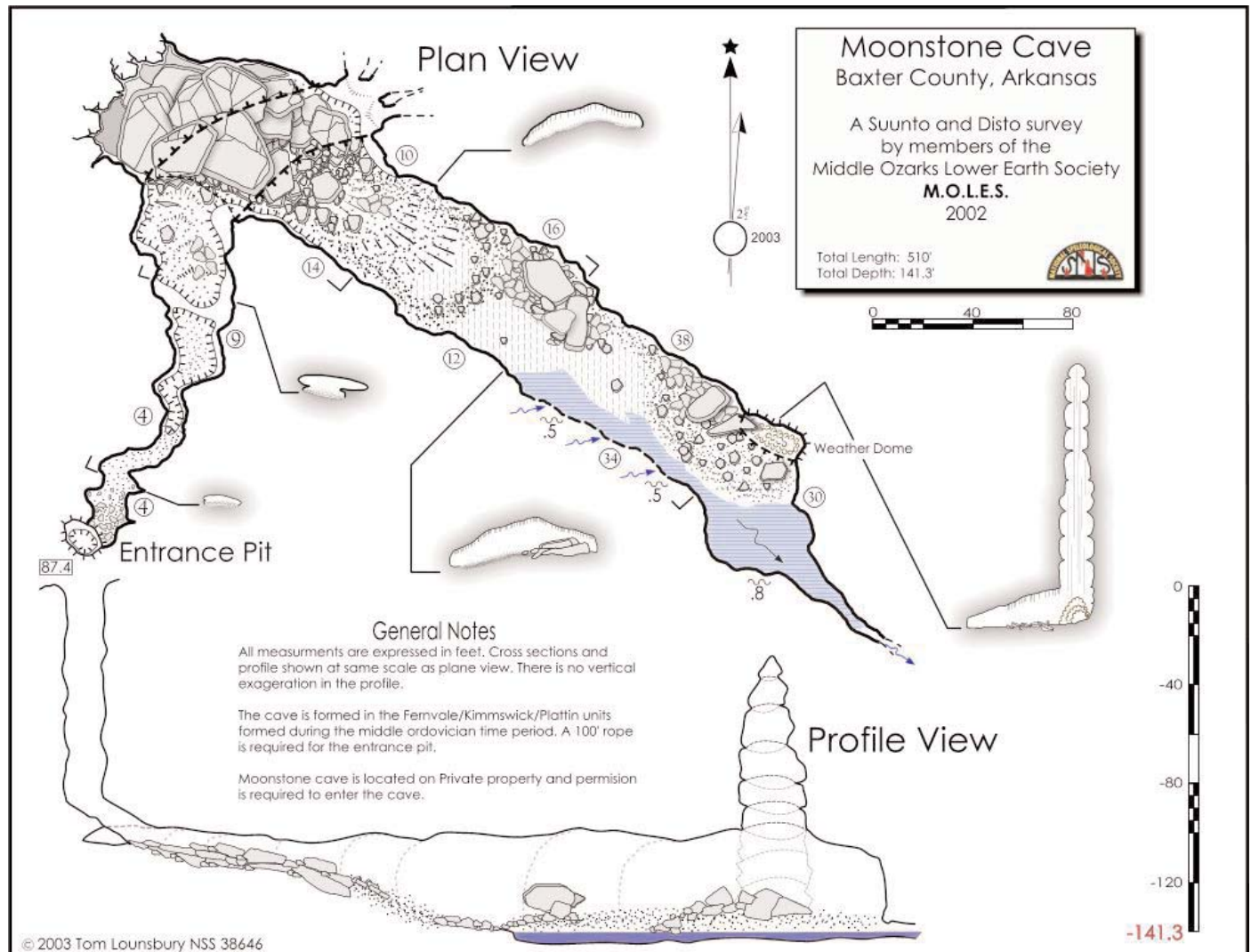


need it in relation to the scale. Its finished. This can be used over and over just by saving it as a template. And importing it when you need it for future maps.

**Conclusion:**

I believe that this tutorial, as simple as I could make it, is a complete testament to the ease and simplicity Xara X has become. I also believe that all of the real basics are covered well enough that you can use Xara to advance your own talents quickly and without a 50 hour learning curve. Try to understand the basic philosophy of the program. Its simple point and click drawing make it one of the easiest programs to master even for the most inept computer user. I am no graphic artist by anyone standards and it would not be difficult for a real pro to work some real map magic using Xara X. Your only limit seems to be your own imagination. Xara makes you a better cartographer while still allowing your own personal styles to come out in your maps. Xara files are tiny and easily attach to most emails and will print at any size with clear crisp lines.

Exporting to other formats is also a joy. I have never seen Xara lock up or tell me I am out of memory. Like I said before, Xara X is the cave mapper dream program come true. Tom Lounsbury NSS 38646





# Carto: Present and Future

By Ralph Hartley

Carto is my tool for making cave maps. For more information see the Carto web site at <http://www.psc-cavers.org/carto/>. For examples of its use see

<http://www.psc-cavers.org/memorial/dec03/> and <http://www.psc-cavers.org/memorial/banquet/>.

This article has three goals. To describe, at least in part, my vision of Carto and its evolution, to make an offer, and to make a request.

In a sense, the offer and the request are the same. Carto is ready for a new mix of users. Most users so far have used Carto in the same way: to make a composite map that is then traced over, either with another program, or with actual pencil and ink. This is fine as far as it goes.

The goal of Carto is quite a bit more ambitious than that! It is intended to go all the way to finished maps.

The Morphing and Compositing features of Carto have been used fairly widely, including for some large projects. Its users include people who are as far from being "computer" people as it is possible to find in the geek centric culture of caving. Some of them contributed substantially to the making of the program usable. One even contributed the tutorial at

<http://www.psc-cavers.org/carto/ganter/tutorial/default.htm>

The "Pencil and Ink" features have not been as widely used, and quite frankly, it shows. Bugs and general clumsiness that would never be tolerated by the "Morphing" users persist. I fix things when people bug me about them, and no one has persistently bugged me about problems in the P&I features. Some bugs I know about, but haven't been motivated to fix, others would only be detected by users that did "not" know how the program works, or how it was intended to be used.

So, what I need now is testers willing to put up with a partially finished and evolving product, users who can separate the "must have" features from the "nice to have".

Early adopters will get something in return. \*Their\* views and needs will have greater

weight. By tolerating an evolving product, they will determine what it evolves into. The final tool will fit their needs best, and they will get free support, roughly in proportion to their commitment.

OK, you know what I want, now for what Carto offers. In the following I will freely mix, with little distinction, completely debugged features and total vaporware (with most being somewhere in between), but will describe nothing I don't know how to do in principle. A great deal of existing functionality will not be mentioned at all.

Carto is an integrated application specially designed for making more or less conventional cave maps. It is written in Java, so it runs on most platforms. Carto is open source. I could go on for pages on why that makes it vastly preferable to any proprietary program with the same functionality (if there were one, but there is not), maybe another time.

So far as I know the only program with remotely similar goals is Walls.

A basic design goal is that nothing should need to be drawn (or done) twice. When survey data changes (errors fixed loop closed etc.) everything gets dragged along automatically. Different views of the same drawing are based on a single original. The importance of this principle is that whenever something is copied or traced, by someone who is not looking at the actual cave (and may never have seen it), some information is lost. In fact, there is a strong sense in which the morphed sketches are "superior" to any inked map, they just aren't as pretty.

The basic drawing primitive in Carto is the curve. Curves can have varying thicknesses, line styles, and fills. The tool for drawing curves was loosely modeled on the tool in Adobe Illustrator, but is still evolving. Curves are more important for cave maps than for typical drawings, which have more straight lines.

Carto has a built in concept of a "passage". A passage has an inside, an outside, a boundary between the two (defined by curves), and "details". Details include morphed segments, fill textures, drawn floor details, text notations, etc..

By default, details are only displayed in

regions that are "inside" the passage. This avoids (for example) the need to retrace the walls when adding a floor texture.

The cartographer can divide the cave into passages in any way (or not at all), but to take advantage of some features of views (see below), they should be defined so that adjacent passages don't overlap each other.

In a cave map, a given piece of passage may be represented more than once, but it is an overriding design goal that nothing should need to be "drawn" more than once, so Carto has a concept of different views of the same artwork.

The most developed instance of this is in the "page" object. Pages in Carto control how the map is to be printed out. A map can be produced as a single big sheet, or as multiple pages, and at different scales. Single big sheets are inconvenient to print, and to use in cave, individual sheets are not as good for display purposes. By allowing the cartographer to lay out pages, Carto supports both.

Another example is where passages overlap each other. The traditional way to handle this is to display details of one passage, and dot or dash the walls of the other, possibly with a detail view with the roles reversed. Carto supports passages hiding or modifying the display of other passages. Which passage is shown, and which hidden, is on a per view basis.

Carto has built in line styles for things like drops and ceiling changes, and the ability to define fairly general additional line styles. Line thicknesses can be defined both in "map" units (e.g. feet), and "display" units (inches, pixels).

Carto also allows user defined symbols and fills. One way for a user to help with the project is by building a symbol library.

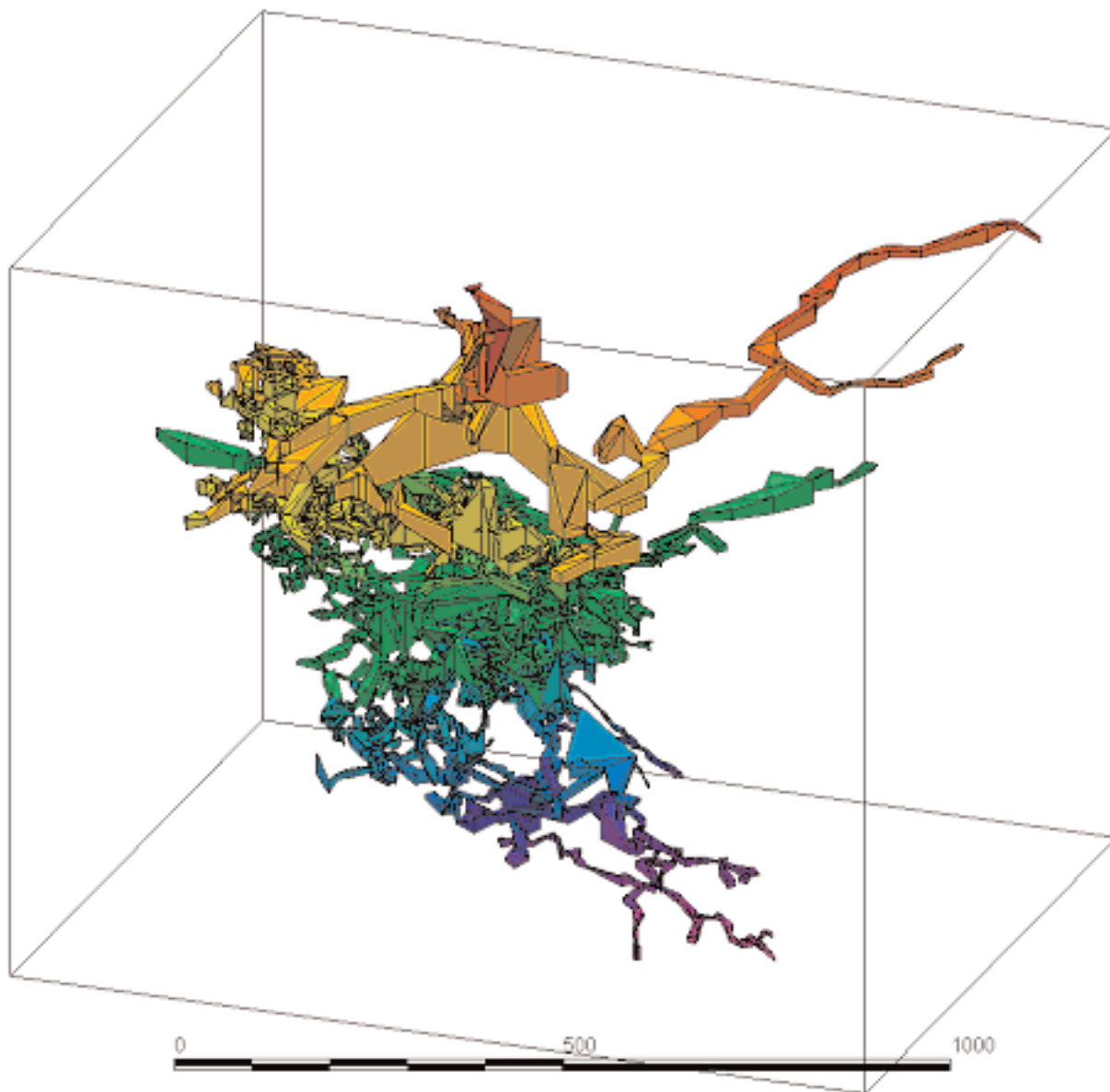
Carto is written in Java, and is open source. I strongly recommend against using closed source software for anything important. I am also open to contributions of code. I don't expect people to understand the code just by looking (but you can browse the code at <http://www.psc-cavers.org/carto/crossref/>), I will try to answer any questions as best I can.

## Creating Survey Groups and Sketch Sheets

By Garry Petrie

Some caves are small. Some caves are simple. A lava tube like Ape Cave in Washington is over two miles long, but only has 5% of the passages in the cave branching from the main tube. Great Ex in Wyoming, while longer, is an example of a limestone cave that follows a watercourse with few branches. Cartographers can draw these caves on a single sheet of paper and software like Walls/Illustrator offers an attractive method for producing a map.

Consider a cave with 10 miles of passages contained in a cube roughly 1000 feet on each side. Imagine this cave has 280 loops. That is the challenge of drawing the "Voids" section of Lechuguilla Cave.



**Figure 1, Passage Model of the Voids in Lechuguilla Cave**

The Voids is the branch of Lechuguilla Cave immediately southeast of the famous Chandelier Ballroom. There are many connections between the Ballroom maze and the Voids. The Voids forms a separate block because the connections all neck down to an area only 150 feet wide. The Voids descends down to the water table at Sulfur Shores and is relatively close to the surface in Yo Acres. How can the cartographer draw a map of the area?

At a fundamental level, most maps represent a view of the surface of the Earth. A surface by definition is two-dimensional. In that regard, cave mapping has the additional difficulty of presenting a two-dimensional view of a three-dimensional object. Cave maps often have pullout views of a section that overlies another section. If the cave geology defines layers, the map of the cave can consist of several sheets confined to each stratum. However, even in the absence of a defining geology, the cartographer can divide the cave survey into layers to show complex passages in a non-overlapping man-

Continued on Page 15



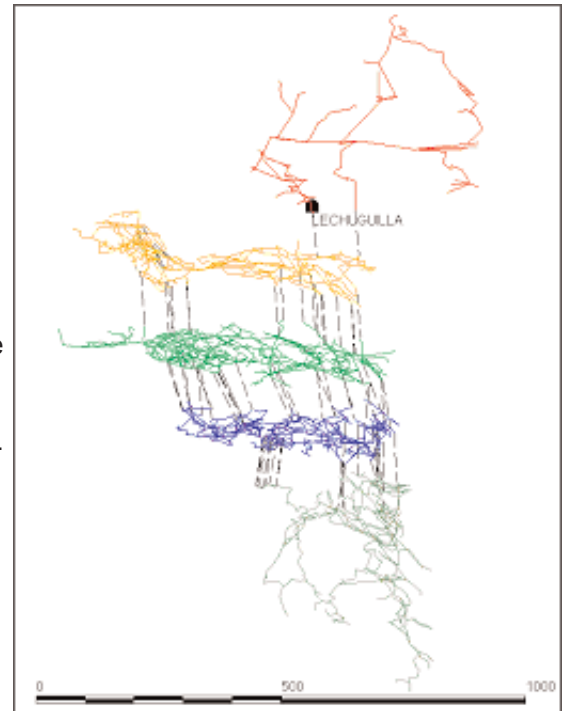
ner. The only restriction is the layers can be no thinner than any room is high within the layer.

The first step is defining the layers or groups in the cave survey. Each group should also form a connected network of shots. With a connected network, the cartographer can export network from the main body of the cave and pin sketches to a plot generated from the new net. The process must be repeatable, so when the surveyors add new survey data to the cave the group definitions remain and expand with the new shots. The sequence should follow loop closure of the main cave survey and then export of the groups. The mapper cannot process an export group further once created.

The main problem with dividing the Voids is that individual surveys descend hundreds of feet. The surveys were broken into simple, non-looping shot sequences before reassembly into groups. The Voids was then broken into five layers, the middle three each about 100 feet thick and the top and bottom layers carrying the balance of the bell distribution of passages. Figure 2 shows each layer reassembled into a new view with control points offset by 100 feet. The dashed lines represent connections between the layers.

The Voids data has over 400 individual sketches. Unfortunately, even within a slice 100 feet thick, some areas have passage too dense to create a non-overlapping view. Certainly, it is possible to subdivide the layers further into thinner slices. However, that runs the risk of creating a view excessively disjoint to be recognized. A natural extension is to generate sheets within each layer.

The two drawings in Figure 3 show different sheets of the same area within the same layer. The cartographer tags each sketch composing the sheet with a label. The room along the FUZZ survey in the upper view overlies the branches off the



**Figure 2, Stretch view of Five Layers of the Voids**

FN survey in the lower view by only 30 feet. Because of the interlocked nature of the overlying passages, it is impossible to compose the map in a single view using the "roundtrip" method and still keep the data consistent. Keep in mind this small view is but two sheets on one of five layers composing the Voids map.

WinKarst, version 11, support both survey groups and sketch sheets. Unfortunately the software does not allow for assigning individual shots into groups. The user therefore must arrange the shots into reasonable sequences first, most easily done with a text editor. Breaking up the surveys that cross layers is a simple as coping the survey information to be shared, e.g. date, team members, and give the second half a unique name. Exporting the group is optional when using WinKarst because the user can view groups as separate object within the program. The user can assign any registered sketch to a sheet in WinKarst. Utilities in the program allow the user to plot only a selected survey group and a selected sketch sheet. If a sketch crosses a layer, the user can duplicate the sketch and assign each to different sheets. Morphing the sketches is optional. The software can auto-scale the entire sheet and export an image file 4,000 by 4,000 pixels. The image file can then form the background layer in one of several popular drawing programs.

WinKarst version 11 was made available in January or 2004.



**Figure 3, Two Sheet coincident in a Layer**

# In a search for the route to 2000 meters depth: The Deepest Cave in the World in the Arabika Massif, Western Caucasus

by Alexander Klimchouk and Yury Kasjan--Ukrainian Speleological Association

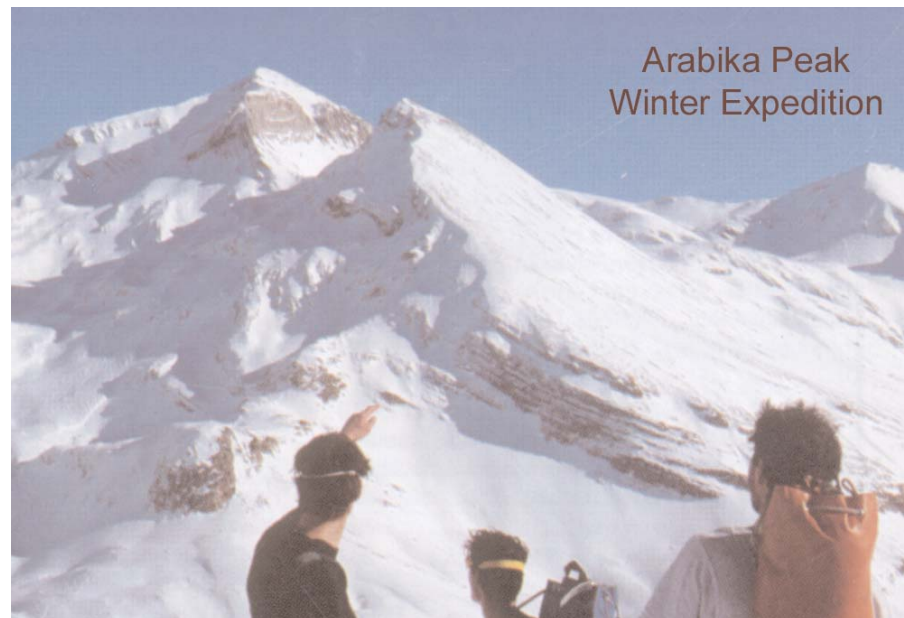
Photographs by Oleg Klimchouk, Denis Provalov, Yury Kasjan, Vladimir Kisseljov, and Alexander Klimchouk

In January 2001, the expedition of the Ukrainian Speleological Association explored Krubera (Voronja) cave in Arabika to a record-breaking depth of 1710m. For the first time in the history of speleology, the world's deepest cave has been explored outside of Central/Western Europe. It stands alone as the most remarkable achievement in super-deep exploration of the recent decades, the largest single breakthrough in depth since 1975. Overcoming of the previous depth record of Lamprechtsofen-Vogelschacht in Austria by 80m is particularly impressive compared to the three previous records, each of which raised the bar no more than 20 meters (to -1602m in 1989, -1610m in 1998, -1632m in 1998). This article briefly describes speleological potential of the Arabika massif and history of its exploration and gives some details of the Krubera cave and the recent record-breaking exploration.

## ARABIKA MASSIF: SPELEOLOGICAL, GEOLOGICAL, AND HYDROLOGICAL FEATURES

The Arabika Massif is one of the largest limestone massifs of the Western Caucasus. It is located in Abkhazia, the republic that officially belongs to Georgia although claims itself as an independent state. The latter is the matter of still unresolved political contradictions between Abkhazia and Georgia that caused the major conflict in 1993-1994.

The massif has strongly pronounced glaciokarstic surfaces at elevations ranging between 1900 to 2500m, and is composed of Lower Cretaceous and Upper Jurassic limestones. In the central part of Arabika the formations of Cretaceous age remained only in some ridges and peaks, as well as in patches within trough valleys. The core part of the massif is composed of Upper Jurassic strata that dip continuously to the Black Sea shore and submerge below the modern sea level (Figure 1, profile). Geologically, Arabika corresponds to the large anticline of the sub-Caucasian (NW-SE) direction with the gentle dipping south-western megafank (complicated by several low-order folds of the same direction) and steeply dipping north-eastern flank. The massif is severely tectonised, with the fault-block structure strongly controlling both cave development and groundwater flow sys-

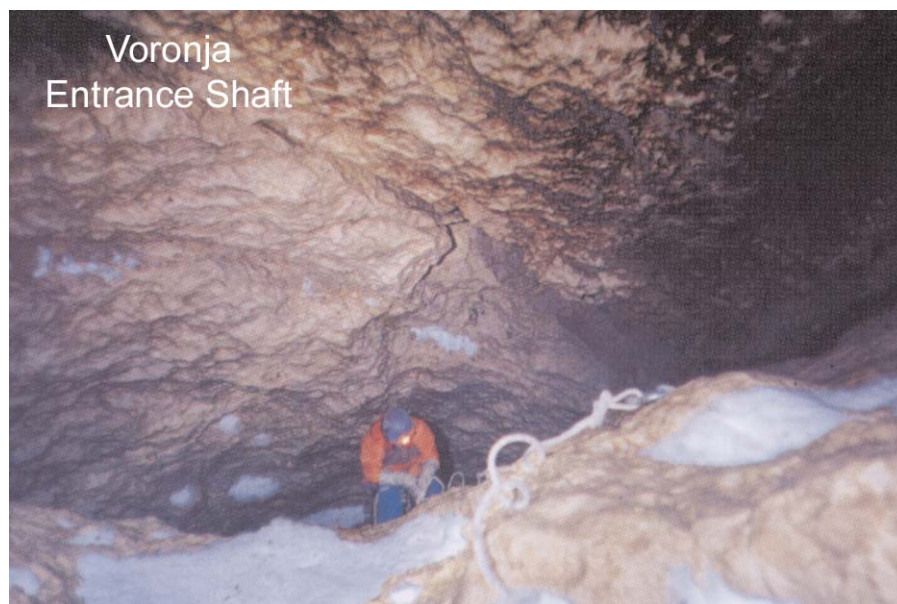


tems (Klimchouk, 1990). On the north-west, northeast, and east, Arabika is bordered by the deeply incised canyons of the Sandripsh, Gega and Bzyb rivers. The latter separates Arabika from the adjacent Bzyb sky Massif, another area of major speleological significance in the Western Caucasus with Snezhnaja Mezhonogo (-1370m), Pantjukhina (-1508m) caves and many other considerable caves.

Glacial trough valleys formed during the late Pleistocene glaciations are the main features of the central part of the Arabika massif (Klimchouk, 1984), with ridges and peaks in-between them. The

central part is shown in beige tint in Figure 1 and indicates the area above the tree line at approximately 1800-1900m. The highest peak (the Peak of Speleologists) rises to an altitude of 2705m. Some low-altitude ridges covered with forest stretch from the central part towards the Black Sea.

Among several hundred caves known in the Arabika massif, some deep caves were explored during the 1980s (indicated by red dots in the Figure 1), including Ijukhina system (-1240m), Arabikskaja system (Kujbyshevskaja-Genrikhova Bezdna; -1110m), Dzou Cave (-1080m), Moskovskaja Cave (-970m), Sarma Cave





(-700m) and Cherepash'ja Cave (-650m). The deepest cave, Krubera, is located in the Ortobalagan trough valley, some 300m to the southeast of, and 60m above the Kujbyshevskaja Cave, the main entrance to the Arabikskaja system (Figures 2 and 3). Although Krubera Cave is not connected directly to the Arabikskaja system, it most probably forms a single hydrologic system with the latter.

Figure 2 depicts quite strong tectonic control of cave development in the plan view. Some segments of the major caves stretch along faults, other parts twist within major tectonic blocks and reflect back inside blocks when reaching a fault. The main branch of the Krubera Cave slew many times and goes steeply in depth by vertical pits separated by short meanders. The cave remains within a small tectonic block and does not extend beyond the limits of the trough valley.

Major karst springs with individual average discharges of 1 to 4 m are located at altitudes ranging from 1m (Reproa Spring) to 540m (Gegsky Vodopad) above the sea. Submarine springs are also known here, emerging from the Black Sea floor at depths of 20 to 40m and probably below. Some boreholes located along the Black Sea shore yield karstic groundwater from depths of 40 to 280m below sea level. An outline of the hydrogeological structure of the massif and its true speleological potential were revealed in the 1980s, when spectacular progress was made in deep cave explorations and two large-scale dye tracing tests (in 1984 and 1985) proved connections between the major caves and springs (Klimchouk, 1990; see Figure 1). Tracers injected in the Kujbyshevskaja and Iljukhina caves were detected in Kholodnaja Rechka (1.5m<sup>3</sup>/s; 50m a.s.l.) and Reproa (2.5m<sup>3</sup>/s; 1m a.s.l.) springs on the seashore. The tracer from Kujbyshevskaja has also been detected in a borehole that yields groundwater from the depth of 40m below sea level, located between these two springs. This gave a reason to distinguish the large Central karst circulation system (number 1 on Figure 1), the deepest in the world at that time with the vertical amplitude being over 2300m. It corresponds to the most of the southeastern flank of the major Arabika anticline. The tracer injected in the Moskovskaja Cave (-970m) have been detected at the Gegsky Vodopad spring, indicating the presence of the karst circulation system comprising the northeastern flank of the Arabika anticline (the Northern system, number 2 on Figure 1). No connections were revealed with yet another major spring, Goluboje Ozero in the Bzyb River

canyon, although it apparently drains a large area in the southeast of the massif (the hypothetical Eastern karst circulation system, number 3 on Figure 1). This outline remains rough, and catchment areas of some other considerable springs (in particular those located in Gagra town) are not yet clarified. Increase of the number of deep caves with shaft flows and further tracing experiments will clarify the picture in the future.

## HISTORY OF KARST STUDIES AND CAVE EXPLORATION IN ARABIKA

Of the rather rich history of karst and speleological investigations in Arabika we shall mention below only some names, events and circumstances which seem to be the most important in the context of the modern state-of-the-art in cave exploration.

In the beginning of the 20th century, Arabika was visited by famous French speleologist Edward Alfred Martel, who published several works about the massif (i.e. Martel, 1909). In 1909-1910 well-known Russian karstologist Alexander Kruber, a founder of karst science in Russia, performed some field studies in Arabika. He published his observations in a series of specific papers (Kruber, 1911, 1912a, 1912b) and in his major monographs. During the following 50 years no special studies of karst and caves of the massif had been done, although the karst of Arabika was referred to in many works dealing with regional geology and hydrogeology.

In the beginning of the 1960s, specific speleological investigations were started by Georgian researchers (Maruashvili, Tintilozov and Changashvili, 1961, 1962; Maruashvili and Tintilozov, 1963). They recognised an important role of the Quaternary glaciations in karst development in Arabika and began to explore caves in the high altitude part of the massif. Despite obvious limitations imposed by poor equipment and technique and the general "infant" state of Soviet speleology then, Georgian researchers explored several vertical caves (up to -250m) and pointed out the considerable depth potential of the massif. In particular, they made a first exploration of an open-air 60m shaft in the Ortobalagan trough valley and named it after A. Kruber, the cave that in the very beginning of the 21st century became the deepest in the world. Forty years ago, however, Georgian speleologists were stopped by an impassable squeeze in a meandering passage that stretched from the bottom of the entrance shaft.

The Georgian researcher Tamaz

Kiknadze made some additional investigations in Arabika, analysed available data on geology and hydrogeology of the massif, and published its monographic description (Kiknadze, 1972). Although his ideas on the structure of karst circulation systems were not confirmed by later dye tracing experiments, this book was an important summary of karst and caves of Arabika.

During the late 60s and 70s the caving clubs of Moscow, Crimea and Krasnojarsk made several expeditions to the massif. Major discoveries were the Genrikhova Bezdna cave in the Ortobalagan trough valley (the 120m deep entrance shaft ended with a squeeze) and the Jubilejnaja, Karrovaja, and Akhtiarskaja caves in the northern part, explored respectively to -260, -200 and -160m. With only six 100m+ deep caves, two 200m+ and no 300m+ deep caves explored before the late 70s, Arabika had acquired somewhat contradictory reputation among cavers ("Good potential but no



deep caves"). Discouragement about Arabika was strengthening by contrast with the adjacent Bzyb sky massif where many 100 to 300m deep caves and several 500m+ caves were under active exploration, including Snezhnaja Cave with its -1380m. By the late 70s, Arabika had been virtually abandoned by cavers. In 1980 the Kiev Speleological club led by Alexander Klimchouk chose Arabika as the main focus for its exploration efforts and implemented a strategy of thorough and systematic search on an area-by-area basis. This appeared to be particularly successful in this formerly glaciated karst massif, in contrast to the previous "quick-search" practice, because of glacial debris blockage of most open-mouth shafts. In



## Speleo-hydrologic map

1 5km

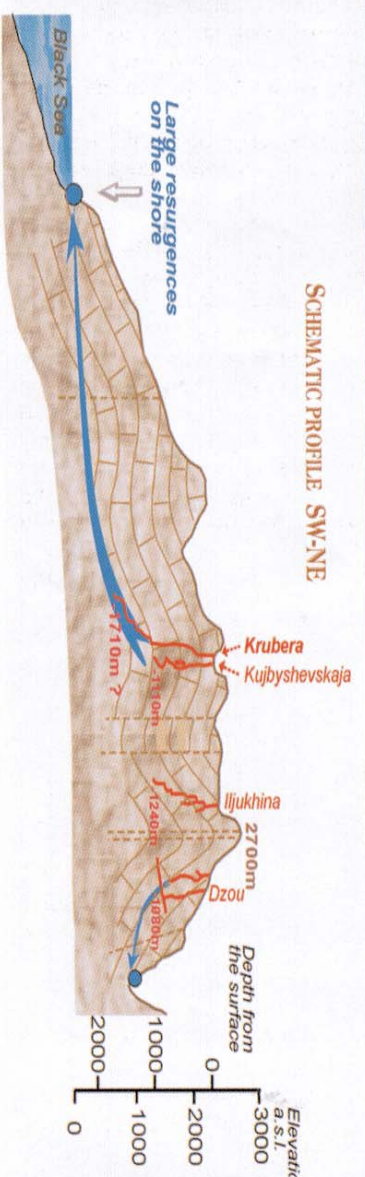
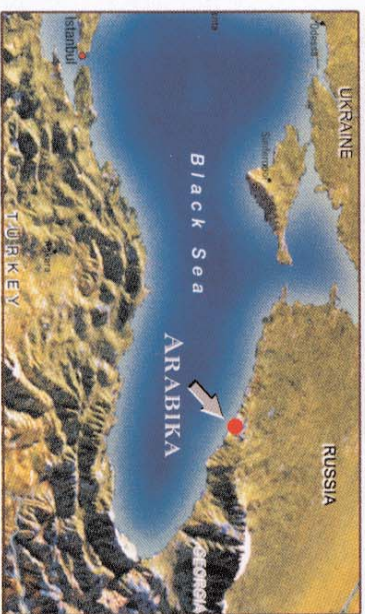


Figure 1: Chart of the Arabika Massif. Below: Location map and geological profile



addition, a "no dead ends" concept was adopted that implied re-inspection of all known caves and systematically challenging such common obstacles as boulder chokes and squeezes that previously blocked exploration. The Perovsky Speleological Club of Moscow, led by Vladimir Iljukhin, joined our exploration activity in Arabika in the same year. This approach quickly led to important discoveries. Kiev cavers concentrated their efforts in the Ortobalagan trough valley where, among other caves, they pushed Kujbyshevskaja Cave through a series of expeditions (-450m in 1981, -700m in 1982, -900m in 1985, -1110m in 1986). The main obstacles in this cave were boulder chokes, penetration through just one of which (Ugrjum-Zaval at -700m) took three years of arduous work. Meantime, exploration progressed in the nearby Genrikhova Bezdna cave, eventually connected to Kujbyshevskaja at -965m in 1989. The resultant system was named Arabikskaja. In the Krubera Cave, which was supposed to connect the Arabikskaja system and increase its total depth by 60m, exploration progressed slowly because of critically tight meanders between pits that required some widening to get through. The cave was pushed to -340m during 1982-1987 and then exploration was suspended. Two "windows" in the P43 in the depth range of 220-250m, indicated on the cave survey, remained unexplored. During this period the cave received its second name Voronja (Crow's cave) due to a number of crows which nested in the entrance shaft. Another cave in this valley, the Berchil'skaja Cave, (located 150m higher than Krubera and 210m higher than Kujbyshevskaja) was pushed by Kiev and Moldavian cavers down through a vertical boulder choke that extended almost continuously from the bottom of the upper 60m deep shaft to the current end at -500m.

Cavers of the Perovsky Club, based mainly in the upstream part of the Central trough valley, invested most of their efforts



in pushing the Perovskaja Cave. The cave was renamed after an outstanding Soviet speleologist, Vladimir Iljukhin, was accidentally killed by a car after the 1992 Arabika expedition. They reached the first sump at -950m in 1984 and spent huge efforts in the subsequent years negotiating through a series of three sumps and "dry" sections in-between them (including a 230m deep section between the 2nd and 3rd sumps). The forth sump, at -1240m, explored for about 100m in length in 1987, remains the end of the system till now. In this extreme exploration one of the leading roles had been played by another outstanding Soviet speleologist, Vladimir Kissel'ov.

Important discoveries made in Arabika by Kiev and Moscow cavers in the early 80s attracted many caving clubs of the former Soviet Union. Cavers from Leningrad, Sverdlovsk, Krasnojarsk, Minsk, Kishinev, Poltava, and also foreign cavers from Belgium, Britain, Hungary, Italy and France got involved in Arabika in various years. All explorations during the 80s were closely coordinated, by planning work ahead for each coming year and assigning certain areas for involved groups.

Results were reported on the regular Arabika conferences held in Kiev after each field season. By the end of that decade, 36 caves exceeding 100m deep had been

explored in the massif, including seven exceeding 500m+ deep.

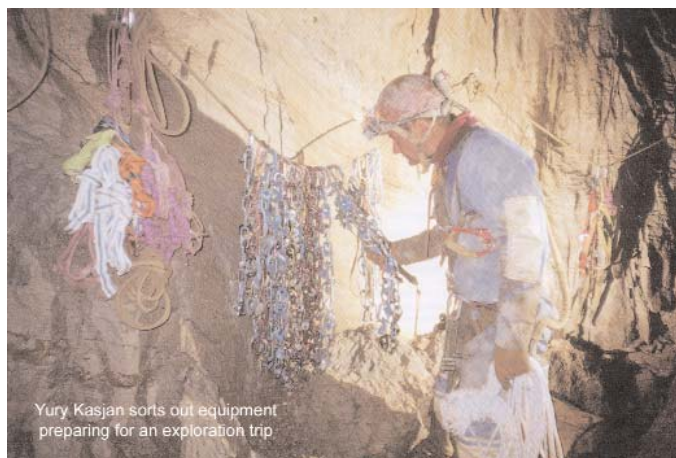
In 1984-1985 two large-scale dye tracing experiments were conducted in Arabika, in which three different tracers were used to trace shaft flows in Kujbyshevskaja, Iljukhina, and Moskovskaja caves. All known springs and boreholes were monitored around the massif. These experiments have proven hydrologic links from Kujbyshevskaja and Iljukhina caves with the major springs at the seashore over a direct lateral distance of 14-20km and vertical amplitude of over 2300m. Obviously, the decade of the 1980s resulted in dramatic progress in speleological exploration in Arabika and in revealing its true depth potential (Klimchouk, 1990, 1991).

The political and ethnical conflict in Abkhazia in 1992-1994 and instability and border problems, which continued throughout the subsequent years, suspended speleological explorations in Arabika. Although some small groups of cavers occasionally visited the massif during this period, planning and realisation of large and serious expeditions was not feasible. Stabilization of the situation in Abkhazia since 1997 has allowed us to re-activate exploration efforts in Arabika.

#### RECENT EXPLORATIONS IN ARABIKA:

##### BREAKTHROUGH IN KRUBERA CAVE

In 1998 the CAVEX team, consisting mainly of Kiev and Moscow cavers, made a breakthrough in the Dzou Cave in the northern part of Arabika, previously explored by French Villefontaine and Moscow Perovo Speleoclub teams



to -493m and after Vladimir Kisseljov team to -750m in another part of the cave. The expeditions of 1998 and 1999 resulted in discovery of a laterally extensive major river passage at the bottom area and in pushing the cave to -1080m. In August 1999 the expedition of the Ukrainian Speleological Association (that included cavers from Poltava, Kharkov, Uzhghorod and Dnepropetrovsk) led by Yury Kasjan, re-started the work in the Ortobalagan trough valley, in the Arabikskaia system, and in Krubera. In fact, the main target was to find a connection between the Krubera and Kujbyshevskaja caves that would increase the total depth of the system by 60m. In Krubera, the team checked the two "windows" in the walls of the P43 in the depth range of 220-250m, which remained unexplored since the 1980s, and found continuations in both. The lower window led to a new branch that seemingly headed toward Kujbyshevskaja, but eventually missed it and ended up with a chamber (Non Kujbyshevskaja) at -490m. The upper window opened to another branch that was explored to -750m during the 1999 expedition. Alexey Zhdanovich from Uzhghorod was instrumental in this breakthrough and exploration. The Ukr.S.A. expedition in 2000 ran in two stages, both led by Yury Kasjan. During the first stage (August), in which cavers from Poltava, Uzhghorod, Kiev, Kotel'va and Novaja Kakhovka participated, the main branch was explored and surveyed to

-1215m. On the second stage the MTDE team, composed of six cavers from Spain (Sergio Garsia Dils de la Vega, Vilafranca Javier la Pera, Enrico Ogando Lastra, Juan Alberto Martin Otero, Aifredo Morena Rioxa, Ramos Ignacio de Rafael) and two cavers from France (Bernard Tourte and Olivie Ubiergo) joined Yury Kasjan and Denis Provalov to continue exploration. They reached a depth of 1410m in a branch piece that seemed to lose airflow and ended with a squeeze. When ascending after the very last trip to the "bottom," Yury Kasjan found a "window" in the wall of a pit at -1340m, which promised to give a continuation. There are many aspects, some of which lie beyond the scope of rational thinking, which experienced cavers evaluate when assessing the prospects for further exploration. In the fall of 2000 we clearly heard "The Call of an Abyss" and felt a smell of the super depth. It was a mixture of knowledge of general prospects of Arabika, historical aspects, impetus of the recent explorations, excellent team resources at our disposal and other, sometimes mysterious, feelings. Even the coming turn of the centuries took its role. We could not wait until the next summer and decided to organise the next expedition to the Krubera cave in the winter, a severe period in Arabika in terms of access and conditions at the surface. Among rational reasons for such decision was a fear of sudden flooding at great depths that could be expected in summer if the cave entered a hypothetical major river passage collector.

A core of the winter expedition, organised under the banner of the Ukrainian Speleological Association, was composed from the members of CAVEX (Cave Exploration) Association, a strong group of dedicated Kiev and Moscow cavers which have extensive experience of deep caving expeditions in winter conditions.

#### THE WINTER EXPEDITION 2000-2001

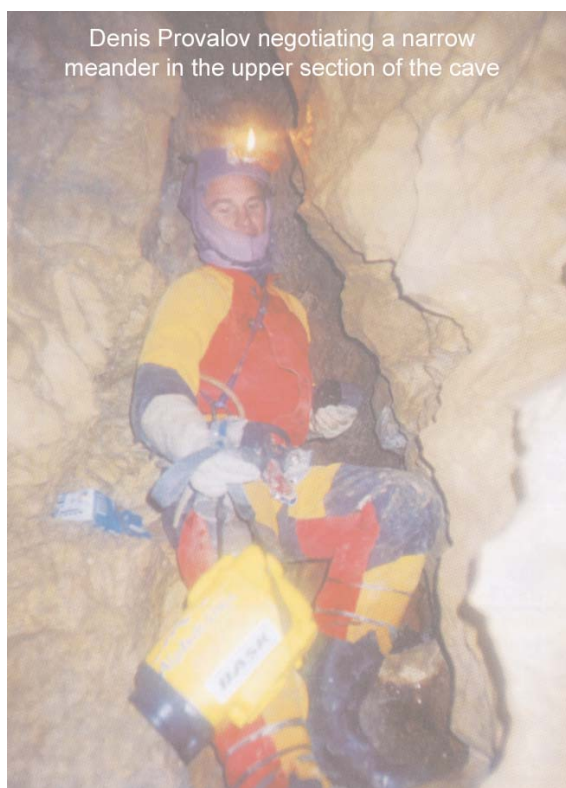
The expedition began on December 25 and consisted of eleven members: Yury Kasjan (the leader), Julja Timoshevskaja and Anatolij Povjakalo (all from Poltava, Ukraine); Oleg Klimchouk, Nikolai Solovjov, Sergey Zubkov (Kiev, Ukraine); Vitalij Galas (Uzhghorod); Konstantin Moukhin, Denis Provalov, Dmitry Skljarenko (Moscow, Russia) and Iljua Zharkov, for-



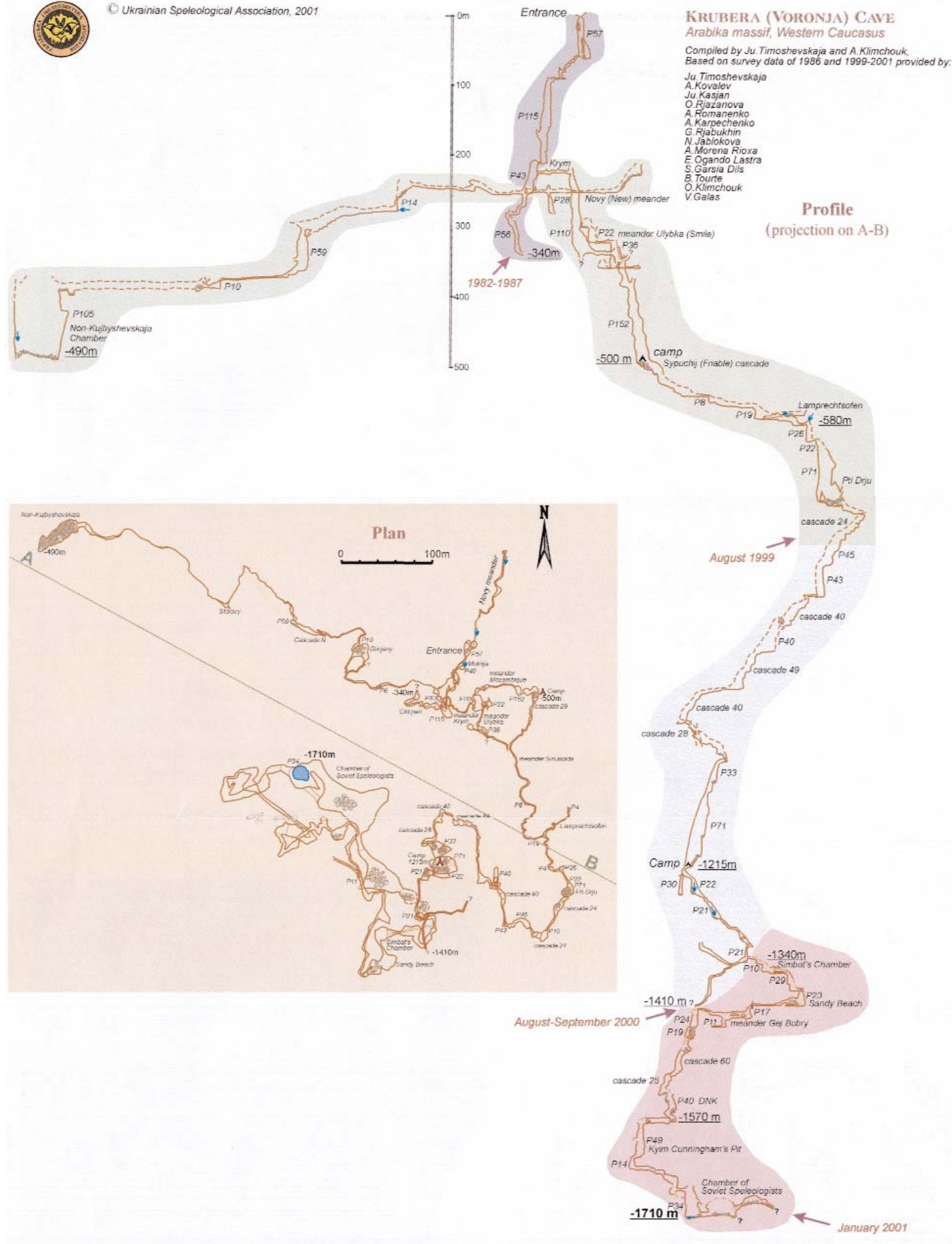
mer Sverdlovsk caver, currently based in Pennsylvania, USA.

On December 27 the expedition arrived in Sochi, the main city on the Russian side, and crossed the Abkhasian border. On December 28 a helicopter from Sukhumi, the Abkhasian capital, brought all members and expedition material to the Ortobalagan trough valley in Arabika. Work in the cave started on December 29 and in the same day the route was rigged to the first camp at -500m. Such a quick start was possible due to preparations made during previous expeditions and ropes conserved at the tops of main pits. By December 31 the route was rigged down to -850m and many bags transported to that point. Meantime, a special team widened three squeezes in the upper section of the cave (begun back in the 80s by Kiev cavers but still being hardly passable) to a degree that allowed easy travel of many people and bags back and forth through them.

On midnight of December 31 all the expedition members gathered on the surface, in a small cave near the camp, converted into a kitchen and dining room, to celebrate the New Year and the beginning of the new century and the millennium. Everything and everyone were prepared to achieve the new world's depth record. On January 1 the work in the cave continued. On the next day an advanced group set up the main camp at -1215m and now no one remained at the surface. All the expedition members carried out various tasks of this assault. On January 3rd the advanced group reached the "window" at -1340m and began new exploration. The right to descend the first new pit in this expedition was granted to the youngest member, Anatolij Povjakalo, who'd had his 18th birthday. By the end of the day a



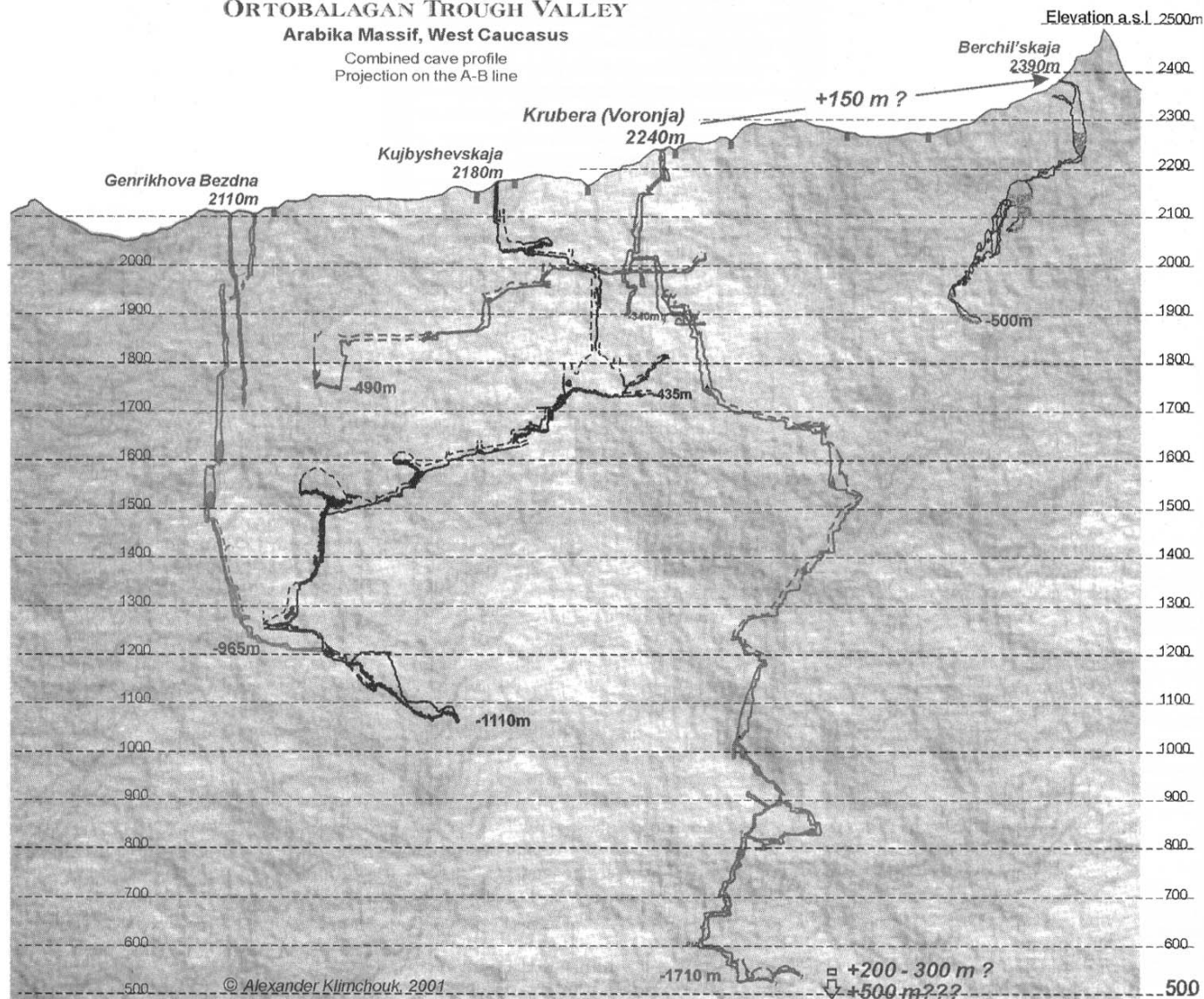




## ORTOBALAGAN TROUGH VALLEY

### Arabika Massif, West Caucasus

Combined cave profile  
Projection on the A-B line



depth of about 1450m was reached. The previous depth record of Lamprechtsofen-Vogelschacht was broken during the night of January 4-5 by the pair of Moukhin-Zharkov. They descended a few new pits, including impressive P49 that went through almost black limestones, reached the depth of about -1680m, and stopped at the mouth of the next pit. This news, delivered to the camp at -1215 on the morning of January 5th, brought all its population into a great excitement. Next, two pairs of explorers went to push the cave further and Denis Provalov went to the surface to bring this news to the rest of the world via mobile phone. On January 6th the news was reported to civilization.

The pit at -1680m turned out to be the last one in this expedition. It led to a big chamber with a boulder choke in the far end, the deepest point reached so far (-1710m). A "window" above the boulder choke led to a series of smaller breakdown chambers but gave no apparent continuation. Four other expedition mem-

bers visited the bottom area for additional inspection, survey, and de rigging. The big chamber was named the Chamber of Soviet Speleologists, to appreciate the long and hard work of many generations of cave explorers of the former Soviet Union leading to this remarkable achievement.

By the night of January 9th all the expedition members and equipment were already on the surface. The next day was spent for recovery and on January 11th everything was prepared for evacuation by helicopter ordered for this date. However, the helicopter had not arrived due to weather conditions in Sukhumi. The time had come to pay for such smooth work in the cave. During the night the weather deteriorated dramatically in Arabika and on January 12th they bid farewell to their hope for a helicopter: a strong wind, heavy snowfall and low visibility. This continued through the next night and the weather forecast for the coming few days, received via phone, was unfavorable. Eventually, the team

decided to leave all the equipment but light camping stuff and force their way down by foot. It was a risky venture due to the apparent avalanche hazard on the way to the tree line, some 5km distance with a considerable traverse. The team, split in two groups, was making a trail through heavy snow with great difficulties when a big avalanche crossed the course just before the first group. It caught and buried a front man, Anatolij Povjakalo. He was immediately dug out, frightened but safe. The night was spent in a forest and in the afternoon of the next day, January 14, the team met a track in the Sandripsh canyon, led by local supporting person Vatik Vartanjan and a caver from Brest, Sergey Krasko. Sergey had arrived by air a day before to coordinate an expected rescue operation. This was a happy end of the active part of the expedition.

On January 16 the weather improved to a degree that allowed making a quick helicopter fly to Arabika to take away the conserved equipment. In Kiev and Moscow the expedition members were greeted by



Glaciokarstic landscape of the Arabika massif: the Zhovekvara trough valley

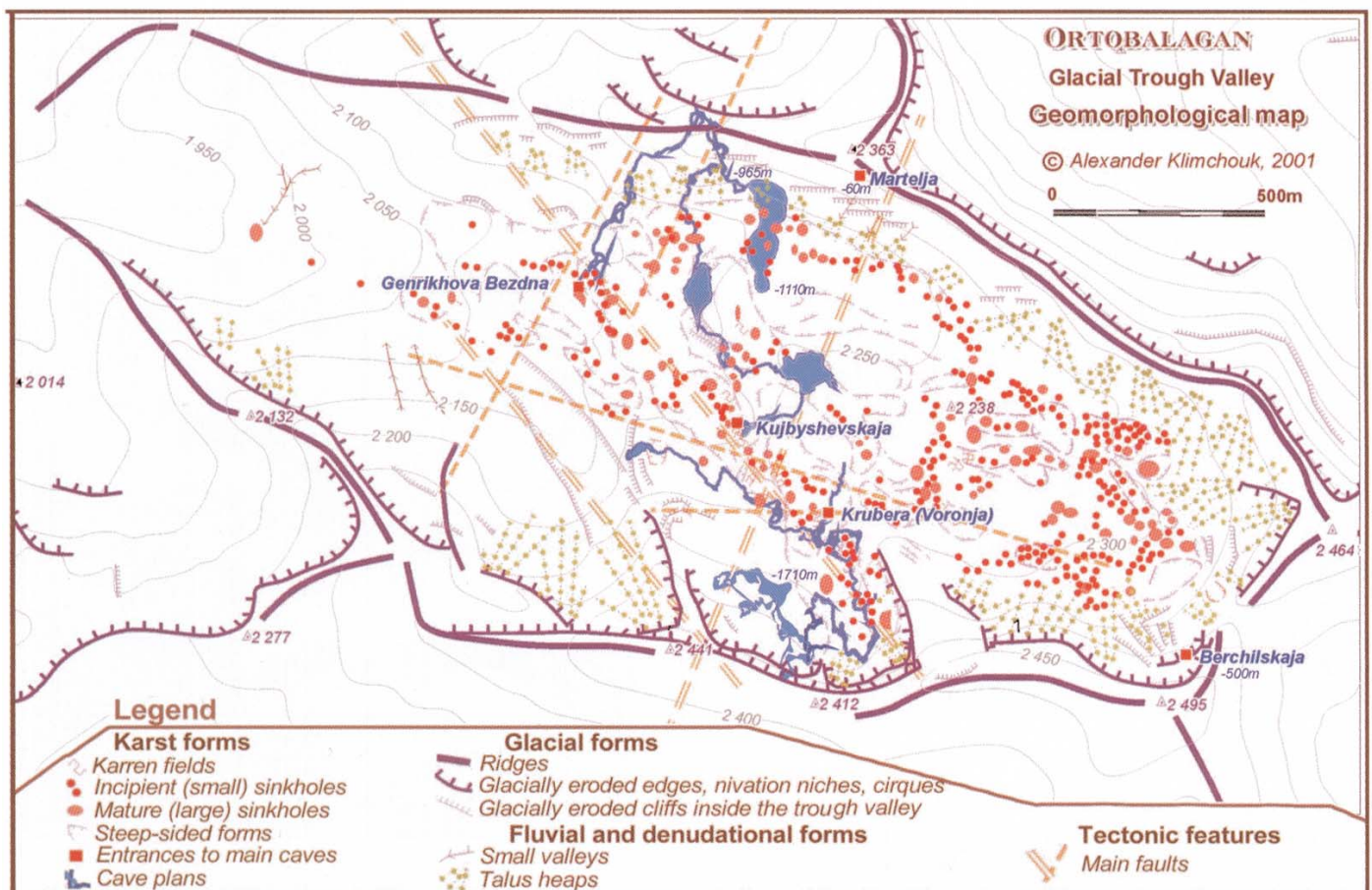


Figure 2: Geomorphological map of the OrtoBALAGAN trough valley





Glaciokarstic landscape of the Arabika massif: the Gelgeluk trough valley

orchestras, champagne, flowers, caving friends, reporters and television crews.

### TECHNIQUE AND EQUIPMENT

The exploration was made using standard European single-rope technique and equipment. The total rigging required over 2000m of ropes and about 300 anchors. Almost everywhere ropes were rigged away from water flows and intense drips so that no dry suits were required to work in the cave.

During the winter expedition two underground camps were used, at -500m and at -1215m respectively. The former camp, located at the bottom of P152, is subject to rock fall hazard. For further works in the bottom area a camp can be set up in the Chamber of Soviet Speleologists at -1710m although a possibility of local flooding due to boulder choke constriction should be additionally evaluated.

The camp at -1215m could accommodate eight cavers. Exploration of the lower part of the cave proceeded continuously in two shifts, through the work of four pairs of cavers. All the expedition members had a chance to work in the bottom area below -1600m and nine of them were at the very bottom.

### SURVEY AND DEPTH ESTIMATES

The survey of the cave was performed using Suunto and Soviet "geological" compasses and clinometers. In addition, two Casio watch altimeters were used to control the depth by repeated incremental measurements. The depth of the lowest point in the cave was 1720m according to altimeters, but 1710m according to the clinometer measurements; the latter figure was eventually taken as an "official" one. In general, the resultant map and profile (Figure 4) correspond to the BCRA Grade 4.

In September 2000 the MRDE team made independent depth measurements up to the -1410m point with two precise altimeters and found a coincidence within five meters with the depth estimates for various points previously made on the basis of clinometer survey.

### BRIEF NOTES ON THE CAVE AND FURTHER PERSPECTIVES

The cave is developed in the thick-bedded and massive Upper Jurassic limestones, in the vault zone of the Berchil'sky anticline. The limestones become increasingly sandy starting from the depth of about 300m, with maximum sand content in the depth interval

of 400-600m, the feature previously noted for the adjacent Kujbyshevskaja Cave.

The main branch of the Krubera Cave develops steeply in depth by vertical pits separated by short meanders and shifts a little to the southern slope of the anticline. Apart from the "Non-Kujbyshevskaja" branch, which stretches for almost 500m to the north west, the cave is looping within a quite small area (400 by 400m), remains within a small tectonic block, and does not extend beyond the southern ridge of the trough valley.

By both the degree of morphological development and hydrologically, the cave cedes to the adjacent Kujbyshevskaja Cave. Small water flow (up to 1 l/sec) appears in the cave at the depth of about 340m. It disappears and reappears on various levels but never increases considerably. At its present bottom at -1710m (530m above sea level) the cave neither enters a main collector river passage nor shows any signs of considerable flooding that would indicate close proximity to its base level collector. These features, together with the previously proven connection of the Arabikskaja system to large springs at the Black Sea shore, suggests clear potential to deepen the cave by at least 150-200m (estimated conservatively) or up to 300-350m with more optimistic estimation.

Equally realistic is the attempt to connect caves with entrances that are at higher elevations into the Krubera Cave main system. The best prospects are the nearby Berchil'skaja Cave (-500m) entered 150m above, and Martel's Cave located some 80m above. Hence, the possibilities of gaining a 2000m + system in this area in the near future are exceptionally good. The Ukrainian Speleological Association and CAVEX Association will continue strong and regular efforts during next several years, both in summer and winter periods, in order to fully explore Krubera and other caves of the Ortobalagan trough valleys with an ultimate goal to explore the first 2000m + cave on the Earth.

### ACKNOWLEDGEMENTS

The BASK and Alpinindustria companies based in Moscow donated some equipment to the winter expedition. The Canon representative office in Moscow sponsored us with video and photo cameras. We sincerely thank them for this help.

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## **Bozhko Cave**

by Dmitri Sitsikhovsky  
(Abkhazia, Bzybisky Massif)

Cave named after Bozhko is located in Western Caucasus in the east part of Bzybisky Massif (Razdel'nyi range). Nearest caves are Progulochnaya, Kholodil'nik, Zemlyanoi, Leningradskaya and others. Entrance is located at about 2000 m above sea level. The nearest peak is Mount Khipsta (2494 m). Main landmark is Turetskaya Shapka (mount Akhibokh 2518 m). Entrance is open in winter and can be seen well from a helicopter. In summer time a memorial plaque above the entrance can act as a landmark. Exact coordinates have not been determined yet.

Bzybisky Massif is very rich in caves. In the Bzybisky Massif more than 400 caves are known. Among them the most outstanding are Snezhnaya-Mezhonnogo (Snowy Cave -1370m deep/19000m long), Shakta Vjacheslav Pantjukhina (-1508m deep/5530m long), Napra (-956m deep/3170m long), and also Suvenir, Pionerskaja, Leningradskaya, Grafski sinkhole, Forel'naya, Bogumirskaya, Mchishta and others. Historically speleological studies of Bzybisky Massif were conducted in several stages. Some early periods in the 1920's are mentioned. In those times studies were of sporadic nature and covered Duripshskoe Plateau and southern foothills of Bzybisky Massif. In the period from the 20's to 60's studies of easily accessible caves were conducted. Geographers (N.A. Gvozdet'skii, B.N. Ivanov, Sh. Ya. Kipiani, L.I. Maruashvili and others) as well as archaeologists and biologists were taking part in the studies. First publications about results of studies began to appear. In 1958 Laboratory of Karstology and Speleology in the Institute of Geography named after Vakhush'ti, Georgian Academy of Sciences, was created. They began to attract tourists and alpine climbers to speleo studies.

In the area there were found altogether 6 horizontal and 7 vertical caves with total length of 387m and depth of -353m. This is why there became an opinion about weak prospects related to the fact that the massif is "located in climate conditions unfavorable for karst development. In the early 70's speleogroups from Moscow State University got interested in studies of Bzybisky Massif at recommendations of N.A. Gvozdet'sky.

In August of 1971 an expedition to the area of Mount Khipsta at 1800m elevation entered alpine meadows and karst fields. Slopes were covered with depressions and sinkholes. In a week tens of deep caves ranging from 100 to 250 meters deep including Snezhnaya (Snowy Cave) cave were discovered.

By 1992, more than 100 expeditions to Bzybisky Massif had been organized by groups from a number of areas and cities of the USSR: Moscow, Krasnoyarsk, Tomsk, Leningrad, Izhevsk, Perm, Khar'kov, Odessa, Crimea, Tbilisi, Minsk, Khar'kov, Ryazan and other towns. The most active cavers began studies of Bzybisky massif in the end of 60's. Dr. V.N. Dublyansky recommended that cavers begin searching efforts in the area of Khipsta and Khipstinskii Gorge. Practically nobody was doing work on the wooded slopes of the Khipstinsky Gorge up until about 1983.

In 1984-1985 new caves including Kan'on, Samokhvat, Veterok, whose entrances turned up above lower rooms of Snezhnaya (Snowy), were found. A suggestion was made that it may become possible to enter the bottom of Snezhnaya (Snowy) to make the way easier to those remote points. This stirred up an interest in the entire speleo community. Even so it still is not possible to enter the bottom of the Snezhnaya (Snowy), but A. Shelepin, T. Nemchenko, A. Bizyukin, E. Snetkov and others should be mentioned among the tireless explorers who have explored and attempted to locate those lower entrances and routes.

In August 1987 a search brought cavers to the east part of Bzybisky Massif. A cave, discovered there struck explorers by its beauty and tough character. At that time it was only possible to go down about 80m. The cave was decided to be named after Alexander Zakharovich Bozhko - the head and honorable member of the Speleotourism Section of KhSU (Khar'kov State University), a tireless explorer and simply a nice person, who died in 1987. Khar'kovsky Speleoclub (SC) "Variant" chose and concentrated its efforts on this particular cave. In the period from 1987 till 1992, 9 expeditions were conducted to the cave, but in August of 1992 the expedition coin-

cided with the beginning of military actions in the region. In that time, Yu. Ivanov and I. Andrenko (the head of the last expedition) were coming back accompanied by the Russian military. Abkhazia then became closed.

### **Morphological Description of the Cave**

The entrance series is represented by an alternation of ledges, wells and meanders and is terminated by an unpassed small-block breakdown choke at -360 m depth. At depths of -80m and -280m there are big rooms suitable for setting up underground camps. At the -290m level there exists an exit through an upper level of one of the meanders to an extensive systems of horizontal galleries, which are developed in cracks of latitudinal and longitudinal directions. Galleries are dry with widths from 1 to 12 m and heights of up to 10m. In some places they are interrupted by blind wells. Galleries are the ceilings of the lower system of meanders, which is confirmed by topographic survey and natural observations. In several places there are passages which connect the old part of the cave with the active parts. Meanders with width from 0.6 to 1.8 m, sometimes more and with active water streams are dotted with wells and cascades. The cave reaches a depth of -500m in one trunk and -426m in the other. Both trunks are terminated by siphons. Total length of the cave as of February 2004 is around 6 km.

### **Hydrology**

Characteristics of the infeeders to the cave is infiltration and condensation. The hydrologic network of the cave is distinguished by a rich diversity. Water appears at -80m deep in the form of pools and drippings. At -120m deep a constant water flow begins to appear, but disappears in breakdown at -360m deep. In the system of horizontal galleries water can be seen sometimes in the form of pools and drippings. Apart from that there is transient waterflow, appearing and disappearing in unpassable cracks.

In the lower level, two large independent permanent waterflows are found. One appears from a siphon at -440m deep and disappears in a

siphon at -500m deep (year 2001), the other comes along a cascade to Ol'khovy meander and disappears in a siphon at -426m. Transient waterflows are noted in the Lokhotron and Val'kin meanders. Temperature of water varies from 4.20C to 4.40C.

Supposedly, there is a connection with the springs in the valley of river Aapsta but dye tracing has not been conducted to confirm.

### Deposits

The most widespread are collapsed deposits. They are present at the bottom of big rooms and practically everywhere in the gallery system. They are represented by gravel and boulders of different sizes, as well as stalactite debris. In streambeds alluvial deposits are noticed, and as a rule they are poorly sorted and poorly rounded. Mineral deposits are present rarely in localized groups. Mineral deposits are represented by thin stalactites and massive stalagmites of white, black and brown color. Among such deposits, pizolites are noticed. Residual deposits stand out in the form of clay layers largely developed in the gallery system and at the bottom of blind wells. On the walls and surface of large blocks there are areas covered with spots of decalcified clay - "leopard skin" ("clay vermiculates"). In the meander system "Zoopark" (Zoo) moonmilk deposits are noticed.

### Results of 2004 expedition

From 1987 till 2004, 11 expeditions, including 9 pre-war and in 2001 and 2004 were organized. Expedition of 2001 was just after a nine year long abkhazian quarantine and not only accomplished a colossal volume of work, but also looked at the cave from a different perspective, objectively and unbiasedly, and evaluated perspectives for possible further exploration. In the course of the expedition, the entire system in all existing directions was re-rigged from entrance for SRT, a huge number of bolts were hammered, and a permanent underground camp was set up at -280m. Mapping was conducted in all the caves main directions. Thanks to discovery of new branches, the total depth of

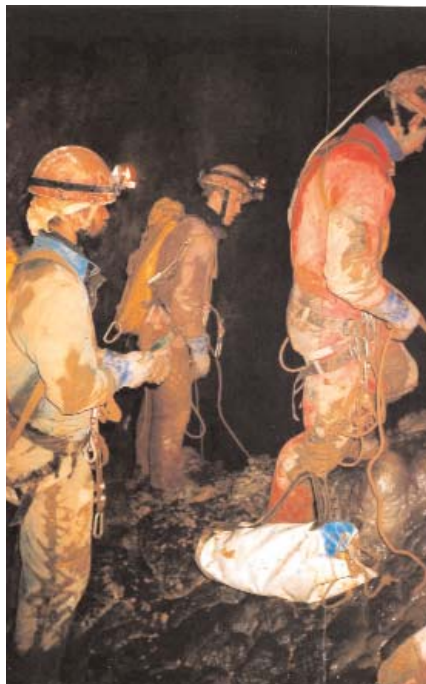
the cave was increased to -500 meters and new areas for future explorations were marked. Nine of those were singled out.

List of participants of the 2004 expedition:

Khar'kov: Ivanov Yuri, Kovalev Andrei, Sitsikhovsky Dmitry, Markovskoi Kirill, Shevchenko Elena, Tivilev Evgeny

New Kakhovka: Fedotov Dmitry

Simferopol': Samokhin Gennady



Poltava: Logvinenko Pavel, Dan'ko Sergey

Samara: Iligin Evgeniy, Khokhrin Vasily, Bednikov Igor'

On January 29, the group was dropped off from Sukhumi from helicopter to the cave. There was so much snow, that it was not possible to dig out the rigging points at the entrance to the cave and the snow shovel broke up apart within 5 minutes of digging. Rigging subsequently had to be made from frames buried in the snow.

Transport of the load to base camp at -280m took place surprisingly fast -with 36 containers (tackle-bag?) being moved in 5 hours. (For comparison, in 2001 it took 14-15 hours for a group of 7 people to transfer 27 containers). In first days of work, Poltava team lpioneers

progressed through flooded Ol'khovyi meander, which had previously stopped earlier explorers. Samartsy (people of Samar team) found a new branch, Russkii Razmer (Russian Size), off of a popular Val'kin meander in the direction of the terminal siphon at -500m with a goal set to bypass it. Traverse of one of the secondary wells in upper galleries of the cave subsequently yielded a whole new network of galleries, passages, meaders, crossings covering more than 500 meters. In the next several days all forces were thrown into the exploration and surveying in this region - Lemuria.

As a result, two simpler and shorter approaches to the far part of the cave, Rasput'e (Cross-roads) and siphon, were discovered. In the same place new branches, dry meanders, tributaries and streams were found. After that work was conducted in far siphon and pre-siphon parts of the cave. G. Samokhin dove the siphon at -500 m. However, due to damage sustained to the breathing equipment, underwater work was terminated. Work continued in the meander, which led to a narrow vertical tectonic crack. An attempt to squeeze beyond was successful and a descent of 30m to the bottom revealed a branch in the direction of a new tributary called Pauk (Spider). At the same time, near in Russkii Razmer the last team explored to an active and powerful

waterflow with lakes and a branched network of galleries and meanders. The surveying team overwhelmed by the complexity of the system of passages, had only time to survey the main path leaving next to every branch a notation with a question mark. This is left for future expeditions.

Survey of Russkii Razmer added another 900m to the cave length and revealed a real perspective of entering the post-siphon portions. Difference in depth locations between the





terminal siphon and Russkii Razmer meander is only 30 m. Presence of vertical wells provide opportunity of bypassing and exiting beyond the syphon zone.

## Conclusion

It is obvious that the cave is extremely interesting and complex. It has great prospects for both gains in length and depth. Overcoming and bypassing the siphon area is possible by further exploration in the Russkii Razmer region (-400 - -500m) and in other areas close by; or by direct penetration using scuba-diving equipment; or further by detection of alternative entrances from the surface.

Some natural observations point to the existence of alternative entrances. In the Lemuria region of the cave the presence of cold airflow is detected in the far part, ice stalactites are found in one of the tributary breakdowns. At those depths (300-350 m) there was also found: bats in the Rasput'e region, and remains of butterflies and other insects in the Zoopark region; live earthworms in the upper part of Lebedinaya Pesnya (Swan Song); and remains of rodents in the area of the Viktoria room i.e. Alleya Mertvykh Son' (Alley of Dead Sleepers).

Increase in the cave length can be also achieved by surveying already discovered parts - only main directions have been surveyed. It is necessary to perform surface surveying as well to place the cave map over the ridge map and to take coordinates of base points including sinks and depressions which could be potentially alternative entrances to the cave. A 3D model of the cave may assist in better understanding the relationships of the cave and the surface as well as aiding in determining the directions of development and possible exit of water. In order to reveal the hydrology, it will be necessary in the future to conduct dye-tracing studies in both active and transient waterflows of the cave. Especially since hydrosystem of Bzyb'sky Massif, judging from dye-tracing experiments of water in Snezhnaya (Snowy) Cave, is very complex and requires a special study. The valley of Aapsta river, where surfacing of dye water is expected, is little explored.

Bozhko Cave presented many surprises and continues to challenge us with new and unanswered questions. Thanks to the coordinated work of a strong and experienced group, it has become possible to perform an enormous amount of work which has helped to determine areas in need of further exploration in the cave. The prom-

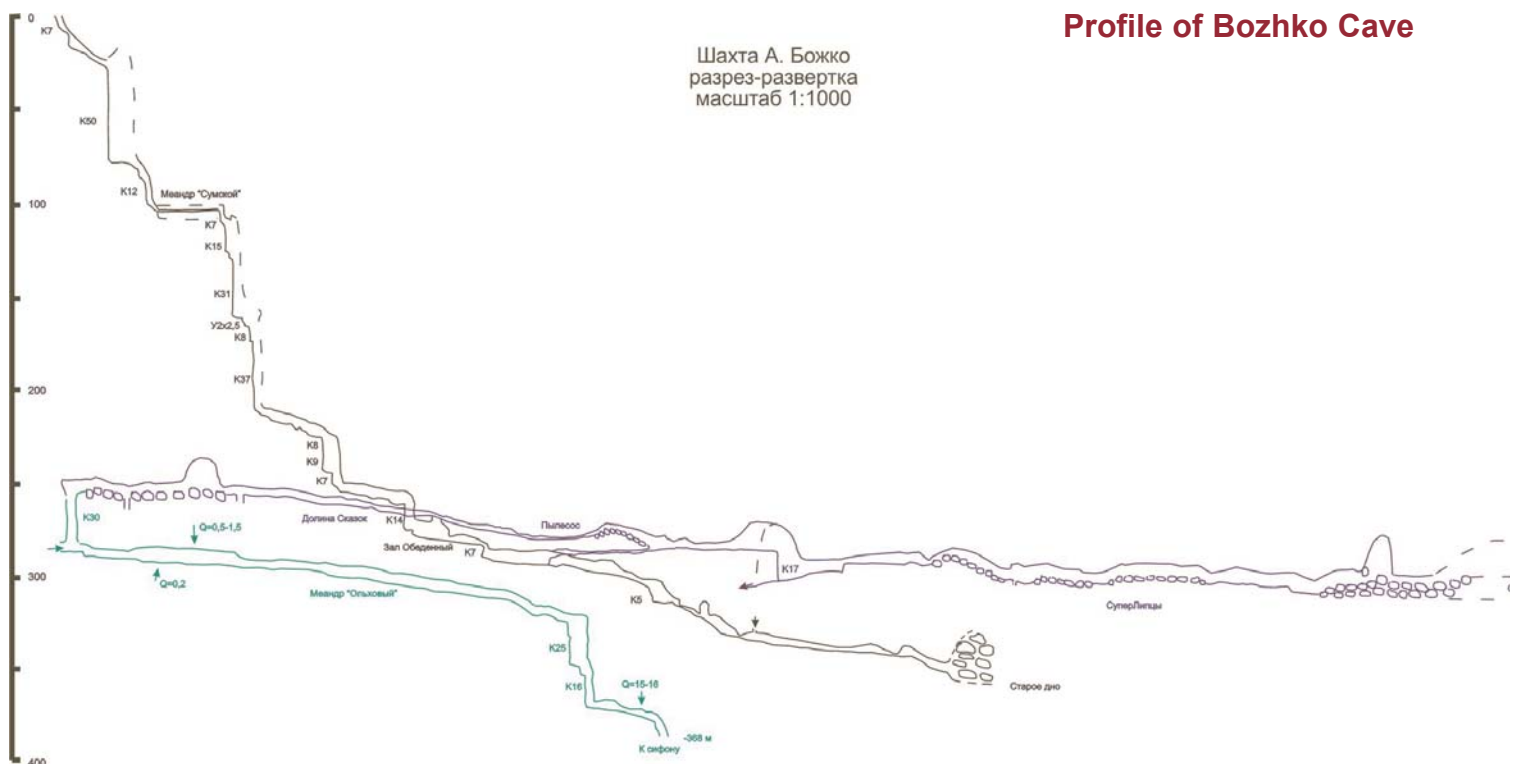
ise of these prospects moves the explorers to organize the next expedition, and even when these leads are completely explored there will be other unexplored regions, which were left after trips in the 80 and 90's. There is enough work for many more expeditions into the future. Since Bozhko Cave, as one of its explorers said, is "a cave for life".

We wish to thank trademark Campus and equipment center "Extreme" - an official representative of Campus, Petzl, Kong Bonaiti, Lanex and others <http://www.extreme-centre.com/>

Sitsikhovsky D.V.

In the article the following materials are used:

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Profile of Bozhko Cave

