# **Cave Volume Calculations and Corrections Using the Compass Software**

# Abstract:

Compass is a cave mapping software product that allows the user to recreate their survey lines in a digital environment. If left, right, up and down dimensions are entered into the software the program can create polygons around the survey stations to approximate the passage morphologies. Currently available Compass software (Project Manager) allows for rudimentary volume calculations based on these constructed polygons which are segmented at each azimuth/inclination change.

A new Cave Volume Tool was created in the spring of 2013 that allows for volume calculations and for determining porosity within cave systems and their host rock. The Cave Volume Tool calculates volumes based on integrating the entire passage into one continuous shape. This tool will be available to the public within the next year.

Cave survey data that are collected using traditional survey methods when put into Compass result in inaccurate volume calculations. This is a result of polygon overlap and incorrect integration of the passage morphologies. With increasing passage complexity (e.g. straight passage to intersections) these volume errors increase. Correction factors have been established using some of the more common cave survey techniques so that more accurate volumes can be calculated. Corrections have been established for straight passages, accurate, obtuse and right angles, intersections, ceiling changes, pits, and chambers or rooms.

By taking multiple random segments of cave survey data the number and abundance of different passage types in each segment can be calculated. Using the correction factors for each passage type a correction factor can then be established for the entire cave system. If cave volume calculations are the end goal for a particular survey, the best way to yield more accurate volumes is through relying on left, right, up and down data associated with each station. The greatest problem with this technique is reconciling floor and ceiling changes with are perpendicular to the survey line. If these data are not available and the cave is relatively short the cave can be 'resurveyed' using the existing map and the method above to generate accurate volume calculations without the need for the correction factors.

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volume.



techniques. Note that in both cases that the rendition is not exact and that the software underestimates the volume.





more accurate shape and volume, whereas the survey down the outside wall produced a irregular shape and over calculated the volume.



height changes down the arm of the T. Running a survey line down all three arms of the T produces a good shape, but overlapping polygons inflate the volume calculations.

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no left-right data.



# **Conclusions:**

effective up to a radius of about 30m.

- (figures 7-10, 12).
- 3. 4.
- correction factor (figure 11). 5. 13).
- 6.



Simple geometric shapes were created to develop correction factors for cave volume calculations in the Compass software (figures 1-6). 2. The Compass software has a difficult time plotting chambers or rooms, however, if the radius of the room can be approximated a correction factor can be established for chambers and rooms under 30m in radius

These corrections only work assuming that the original cave survey data has left-right-up-down data associated with it (table 1). If the original cave is relatively small it is relatively simple to resurvey from the original cave map so that there is no need to develop a

If there is no left-right-up-down data associated with the original cave survey data random sections of the cave can be resurveyed and the volume correction can be extrapolated across the entire cave (figure

These volume corrections can be applied to the new Compass software and can be used to determine a more accurate volume of the cave and has applications for cave morphometric analysis, porosity calculations and carbonate reservoir characterization.



	Center		Outer Wall		Inner Wall	
	Project Manager	Cave Volume Tool	Project Manager	Cave Volume Tool	Project Manager	Cave Volume Tool
	0.27%	0.27%	0.27%	0.27%	0.27%	0.27%
le	-5.12%	-9.44%	0.00%	12.32%	-22.77%	-38.15%
le	-7.16%	-14.89%	-16.34%	26.40%	-28.92%	-31.82%
ngle	3.53%	1.91%	21.03%	20.59%	-7.65%	-8.53%
Intersection	0.00%	14.29%	0.00%	0.00%	N/A	N/A
Intersection	11.02%	11.11%	N/A	N/A	N/A	N/A
	0.00%	0.27%	0.00%	0.00%	0.27%	0.27%
	11.02%	-14.89%	21.03%	26.40%	-28.92%	-38.15%
	0.42%	0.54%	0.99%	11.92%	-14.77%	-19.56%
Deviation	6.49%	11.32%	13.27%	11.86%	13.43%	18.36%

approximated using the Project Manager volumes as: [20 (0.27%) + 7 (-16.34%) + 4 (-22.77%) + 1 (11.02%)] / [20+7+4+1] = -5.91%. This tells us that the Cave Manger output underestimated the volume of the cave by approximately 6% of the total volume. If the Cave Volume Tool was used the error would be: [20(0.27%) + 7(26.40%) + 4(-38.15%) + 1(11.11%)] / [20+7+4+1] = 1.52%. This treatment tells us that the Cave Volume Tool output overestimated the volume of the cave by approximately 1.5% of the total volume. These corrections are useful because when the new Cave Volume software is used that can calculate surrounding rock volumes, the true cave volume can be applied in calculating cave-host rock porosities.