HOW I LEARNED TO LOVE CROSS-SECTIONS

Testimonial from a survivor of GCSS

by Jeff Bartlett

The Affliction.

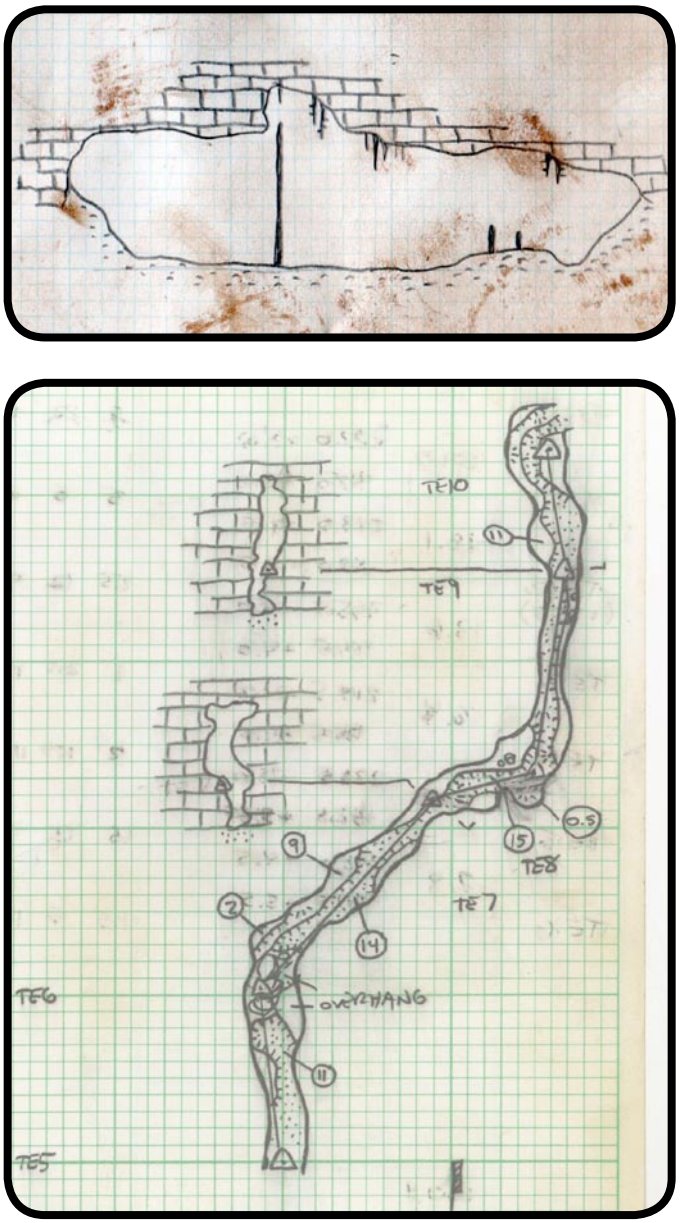
In spring of 2008, I was diagnosed with Gutless Cross-Section Syndrome (GCSS). At the time, I had sent some sketches to *CRF's* chief cartographer, Bob Osburn, with hope of being approved for sketching in Mammoth Cave. I received the approval. But, along with other suggestions on how to improve my work, Bob pointed out the clear symptoms of my malady: in the example I'd provided, three passages converged in a tall room, and I'd drawn cross-sections in each of the three (none of which were particularly unique) without giving any thought to the room.

He was right! I'd fallen into an obvious trap. I'd followed the path of least resistance. With 2 or 3 cross-sections per page of sketch, who could complain? Besides, cross-sections are a pain, right? You have to switch gears, mentally, from drawing the plan view in order to do them, and then you have to switch right back. I viewed them as speed bumps, necessary evils slowing down my survey pace.

Soon, I saw the error of my ways, and with therapy my GCSS symptoms began to subside. Cross-sections became not a quota to meet, but a riddle to solve. In fact, not only was I cured of gutlessness, they are now my favorite part of sketching and drawing maps.

The Challenge.

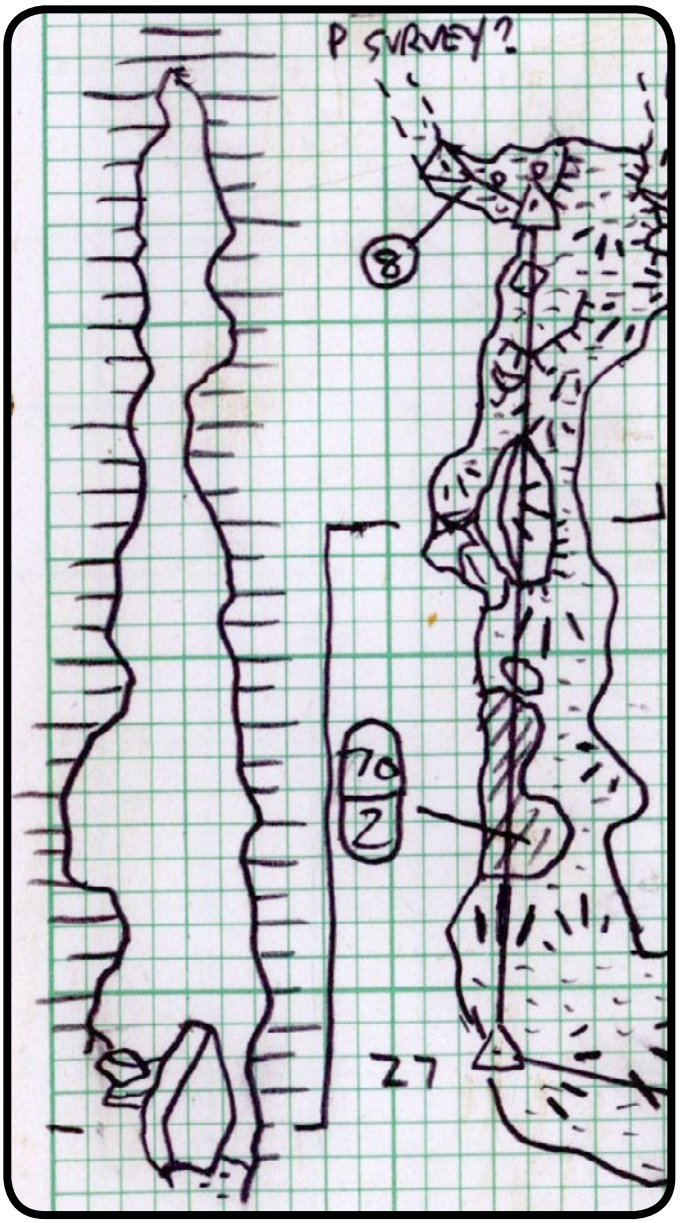
Sketching is the translation of a three-dimensional cave into a variety of two-dimensional forms, and as much of the effort goes into the translation itself as does the physical act of drawing each line. The more complex the passage, the more difficult the sketching becomes. Frequently, features are encountered that give the sketcher pause. This protruding ledge… is that drawn

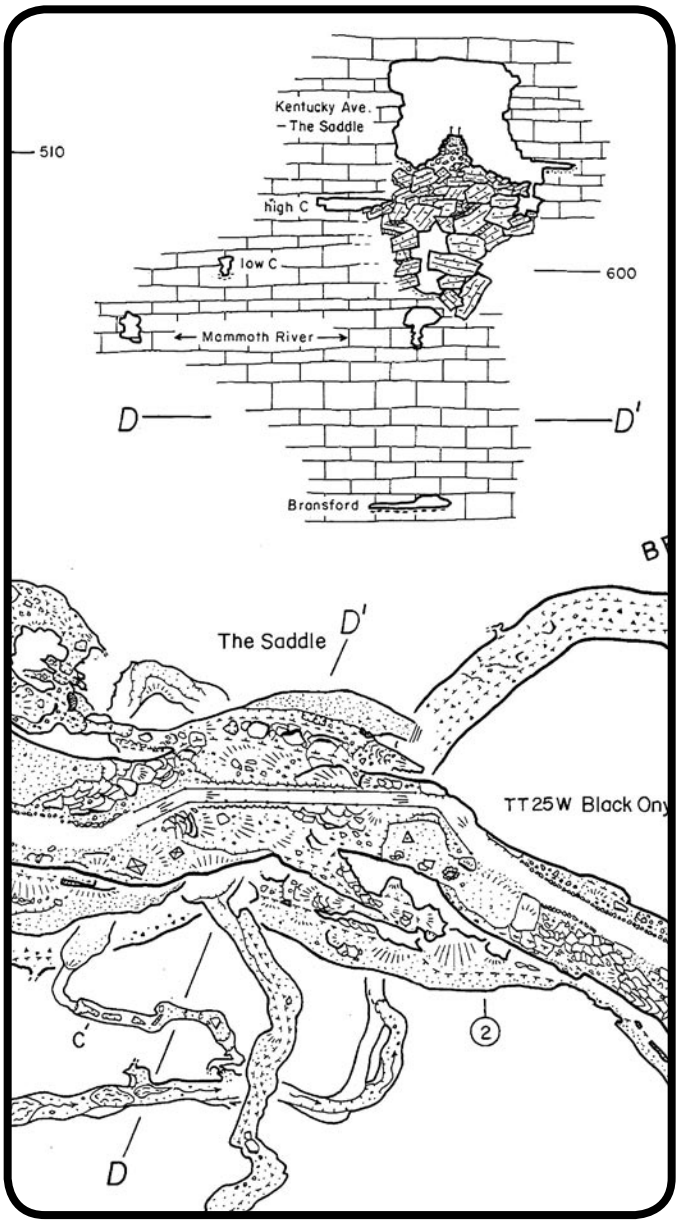


Page 40, top - In some situations, a cross-section can express a cave feature much more clearly than the plan view. How better to describe an 18' tall totem pole? Bottom - In canyon passages, where it's often difficult to define walls on multiple levels (or explain different types of ledges), frequent cross-sections cut to the chase.

as a ceiling drop or a floor drop? After all, depending on one's perspective, you can be either above or below it. That horrifying jumble of chocked breakdown in the ceiling… how do I draw this noteworthy feature without obscuring the plan view below it?

Often the answer to these cartographic questions lies with the cross-section. After all, when the cartographer drafts a cave survey, he or she is attempting to explain the cave to the map viewer; In order for this to



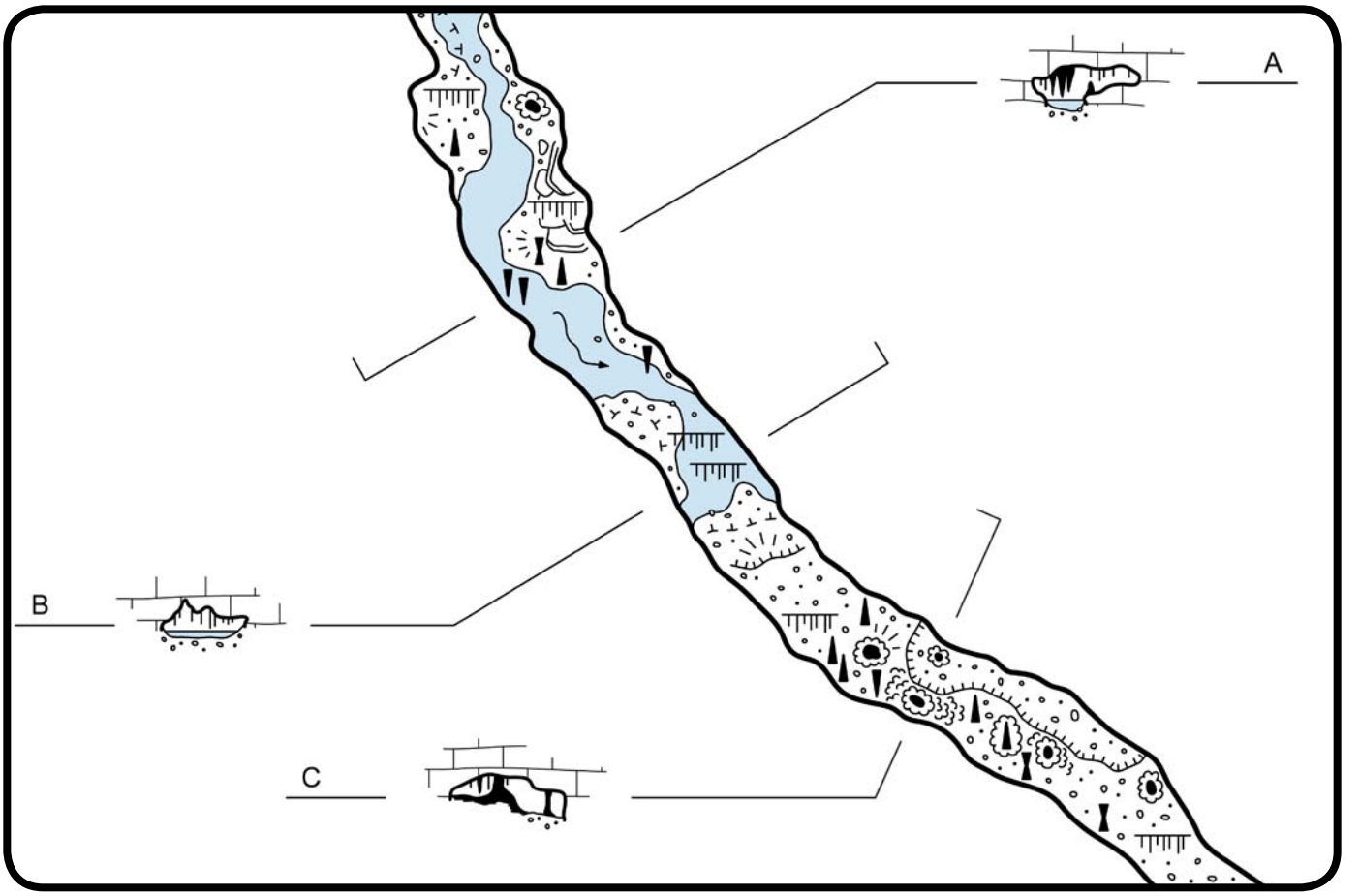


Page 41, top left - Since they mimic the caver's perspective of a passage, cross-sections can be more explicit than symbols on the plan views. Sure, the height bubble points out that this passage is 70' high, but the cross-section hammers it home. Top right - Large upper passages that obscure those below only worsen an already complicated cartographic situation. Offsets can show the obscured passages, but to adequately express the relationships from passage to passage, the only suitable option is a composite cross-section.

be possible, the cartographer needs to thoroughly understand what has been recorded by the sketcher. This is one reason it is most helpful to have cross-sections at each station, and even at interesting features between stations. An abundance of cross-sections helps the cartographer comprehend the nature of the cave passage without a field check, and this comprehension allows good decisions to be made about how to represent the passages and rooms on the final map.

Therefore, it is precisely at a cave's most difficult junctions that cross-sections are most useful and necessary. Whenever you, as sketcher, find yourself pausing to figure out the best way to show a given feature on the plan view, be sure to draw a cross-section as well.

Much in this same vein, cross-sections can offer opportunities to express cave features that just cannot be shown in a traditional plan view. For example, Chinn Springs Cave has several large, unruly helictite clusters that resemble upside-down fir trees. Sure, you can just write "grotesque helictite formations" next to the passage on your plan view… or you can draw a cross-section and show exactly what you mean.



Above - Often, the cross-sections are necessary to finish the thought. Without cross sections (ceiling heights intentionally omitted), the passage looks like a wet, chert-floored stream passage with quite a few formations. Add them in, and your map readers will probably notice that A and B require full-body immersion to prevent damage to delicate features!

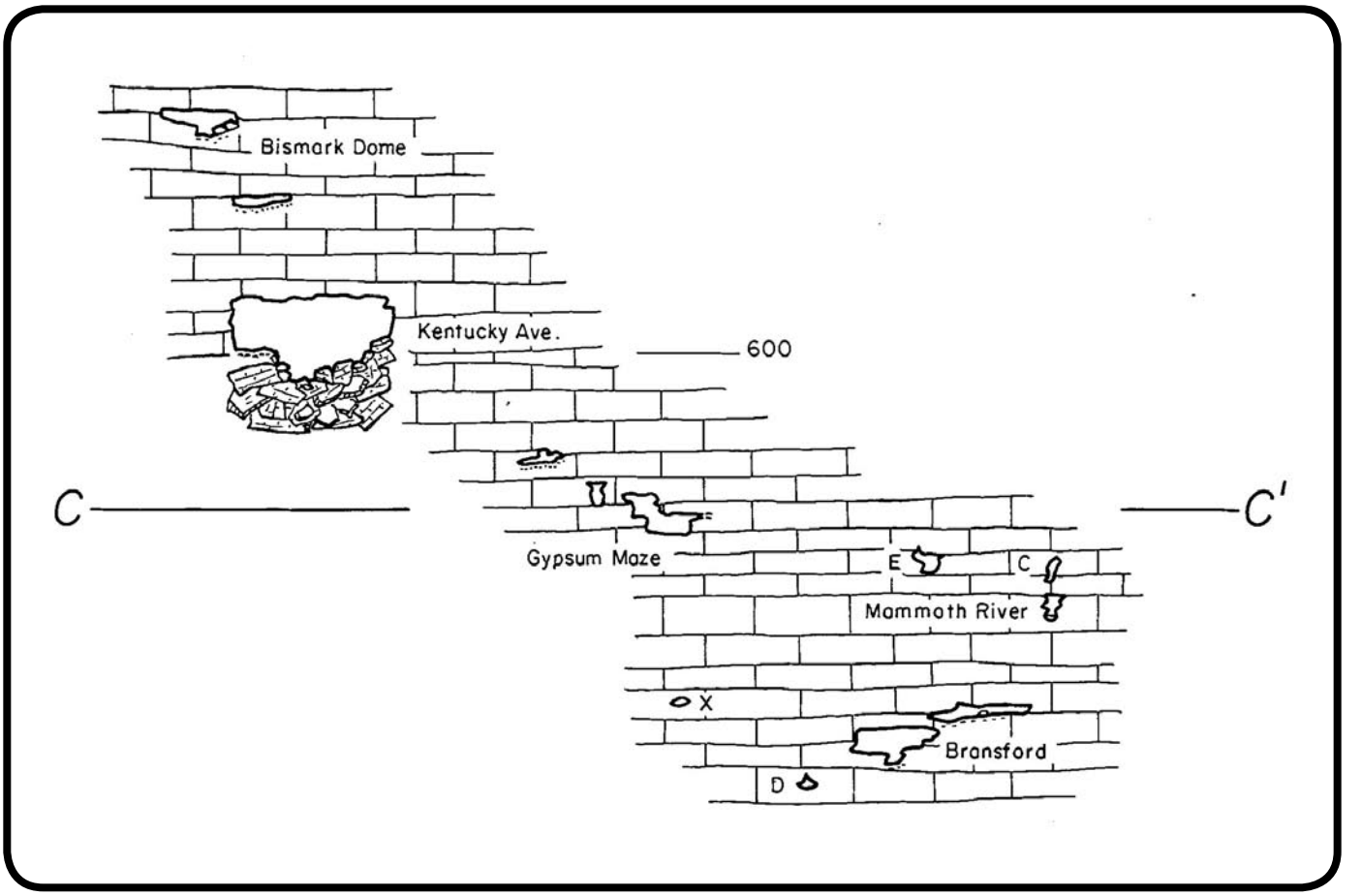
The remedy for GCSS, indeed, is a strong counter-attack. I've begun to seek out the most challenging and complex cross-sections to accompany my sketches. These not only help the cartographer, they are the most interesting and rewarding to draw. Hey, why just draw the shape of the tube at a given station when you can move 20 feet down the passage and draw that series of weirdo phreatic holes in the ceiling that you couldn't cram into your plan view?

The Caver's Perspective.

Of the different views presented in a typical cave map – Plan, Profile, and Cross-Section – the cross-section is unique in that it shows the "caver's perspective" of a cave passage. Ever try to find a poorly marked tie-in to an existing cave survey without a cross-section? It's difficult, because the cross-section bears the closest resemblance to the way we see cave passages while traversing them.

This resemblance has a profound, direct effect on the usefulness of a cave map. Map users can relate to good cross-sections more readily than a plan view, the latter of which is more symbolic. In this respect, the cross-section becomes the opportunity for a sketcher or cartographer to explain what a passage is actually like. A 10' tall passage and a 100' tall passage might look the same in plan view, but they sure don't look the same in cross-section. More dramatically, a 6' tall passage filled with ankle-deep water might look the same in plan view as a 6' tall passage filled with neck-deep water, but the cavers making use of your map will thank you for the cross-section that lets them know what they're actually in for.

The first time I drew a cave map, I showed an in-progress version to a friend. It did not yet include cross-sections. "So, is this walking passage over here?" he said, tapping a finger on a particular passage. The clearly-visible ceiling height bubble, which noted the passage as being 1' high, told another story. I realized that, if sketching and drafting a cave map is a translation



Above - In extraordinarily complex regions of a cave such as this one, it would be wholly impossible to express the vertical relationships between passages without these types of ambitious cross-section composites. Combining a dozen or more cross-sections in this fashion requires that each sketcher has been diligent about providing them.

to a 2-dimensional format, then reading a cave map requires a similar bit of translation from 2 dimensions to the imagination of the viewer. After all, a height symbol is a perfectly acceptable way of expressing the vertical nature of a passage.

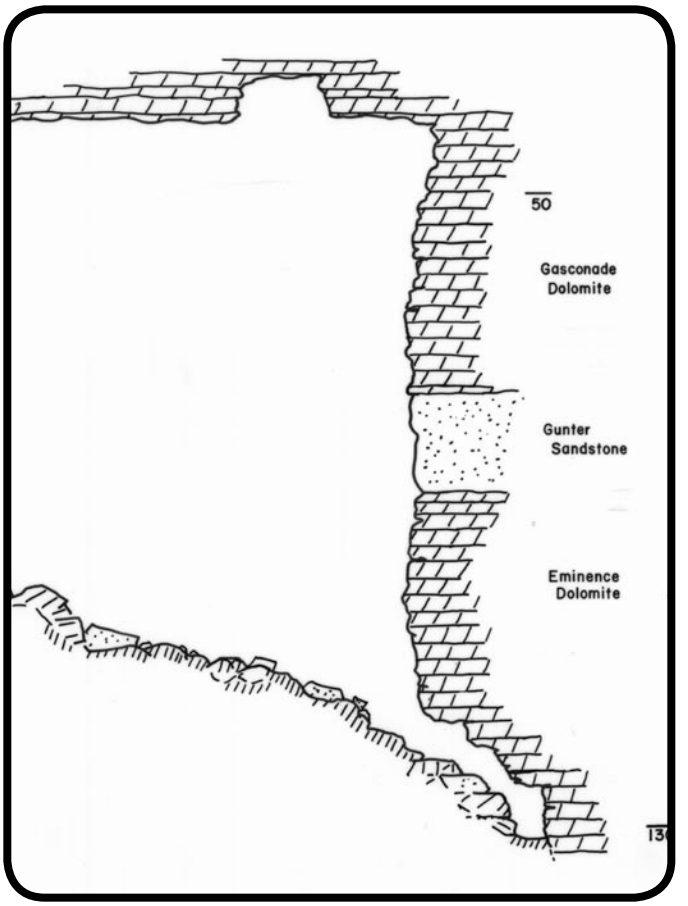
Yet, much of the value of a cave map lies in how easily it can be understood by those who make use of it. The task of cartographer is not just to commit a cave to paper but also to make it easy for the viewer to interpret and make use of. In this light, the map user can immediately relate to a cross-section, since it mirrors what they see while inside the cave.

Cross-sections, being drawn from the perspective of the caver, thus bridge this gap between symbols on paper and reality, and provide a recognizable reference for the end user. The different parts of an in-cave sketch combine not only to show what a cave *does* but what the cave is *like*, and cross-sections are the weapon of choice for describing the latter.

Passage Relationships.

In caves with adjacent passages or multiple levels, the best -- and sometimes only -- way to explain the relationship of passages to one another is to draw composite cross-sections. In complicated caves, especially those where multiple passages overlap each other along a common fault or vertical plane, this can be the only way to adequately illustrate their distribution. Where passages are especially dense, these representations can be truly mind-boggling, and even on simpler maps nothing compares to a good composite for explaining how, say, a room corresponds with a canyon above it.

In order for a cartographer to be able to composite cross-sections from multiple routes along a common plane, he or she must assemble single cross-sections from each into a whole. This is rarely done in-cave, as typically the nearby passage(s) have been surveyed separately (however, in instances where meanders deviate from a main passage and return to it, it's helpful



Above - This cartographer has utilized geologic information from the sketches and displayed it on the final map, both with USGS-standard lithologic patterns and notes describing specific strata. This is an advanced technique, requiring additional field work, but is of high value in some cases.

for the sketcher to draw a composite to show the correlation between them). With a collection of cross-sections from different surveys along the same plane, the cartographer can utilize the survey data in order to display the correct spacing between passages, providing a complete picture.

This underscores the necessity for a sketcher to draw cross-sections frequently, and preferably at each station; with more available, the cartographer can successfully fuse the individual drawings without wasting manpower on trips to collect additional cross-sections in critical areas. Indeed, with enough cross-section instances available, the cartographer can opt for combinations at the most cartographically useful places, not just the places where he or she is lucky enough to have cross-sections that line up appropriately. It is, thus, critical in these situations that each sketcher provide an abundance of cross-sections.

Lithology.

It is critical to not only provide the shape of a passage but to also include an indication of floor and wall materials. In the old days of "walls only" cave mapping, cross-sections followed suit, drawn as a single line and only as descriptive as a silhouette. However, modern cave survey techniques demand that the sketcher explain whether, for example, a given wall is composed of solid limestone or whether it's an indeterminate jumble of breakdown blocks. Simple symbols are used to show which portions of a passage outline are sediment or bedrock, and these "finish the thought" for the map viewer as well as the cartographer working from your sketches.

An even more detailed technique, where applicable, is show specific stratigraphic layers. This is not particularly common, and requires the sketcher to have knowledge of geology and the ability to observe the bedding planes; in some places, these are obvious to the layman (a chert layer or nodules jutting out of a wall, for example) while in others the difference between adjacent limestone formations can be gradational or otherwise indistinct.

However, in caves where the influence of multiple observable strata have had a major impact on speleogenesis, the extra effort may be well worth the trouble. The USGS publishes a PDF list of suggested lithologic patterns for common sedimentary rock on its website[1].

Methods.

Drawing cross-sections efficiently can be productive and satisfying. Once I've decided where to draw one, I add the leader lines and lightly define a box for

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1 *The Federal Geologic Data Committee's "Digital Cartographic Standard for Geologic Map Symbolization," specifically Section 37.1 relating to sedimentary lithologic patterns, can be found at http://ngmdb.usgs.gov/fgdc_gds/geolsymstd/fgdc-geolsym-sec37.pdf. In fact, the USGS provides pattern swatches for use with digital vector drawing programs; these can be downloaded toward the bottom of the web page at http://pubs.usgs.gov/tm/2006/11A02/. These patterns, not surprisingly, correspond to those shown on page 137 of On Station.*

width and height using the LRUDs[2]. Be sure to indicate which way the cross-section is facing, and include the leader lines to show its exact location and angle of direction. Next, sketch the outline of the passage, including those portions which may fall below water level. Some sketchers find it helpful, for sake of scale, to include a stick-figure caver in their cross-sections.

It is also important not to make assumptions while drawing the outline. From *On Station,* by G. Dasher:

> *All cross-sections should be displayed open-ended whenever there was an indeterminate wall, a ceiling or ceiling alcove that was out of sight, or when the surveyors could not touch bottom in a swimming passage. Do not make up information that was not observed.*

Here is where you will add your passage features and lithology, drawing any breakdown blocks or formations as well as the composition of floor materials and bedrock walls. It's not important or necessary to meticulously draw each "brick" of the limestone symbol (*see the example at top left of page 41 for a common in-cave "shorthand" version*), only to clearly depict which walls are actual walls and which are sediment, breakdown, cobble, etc.

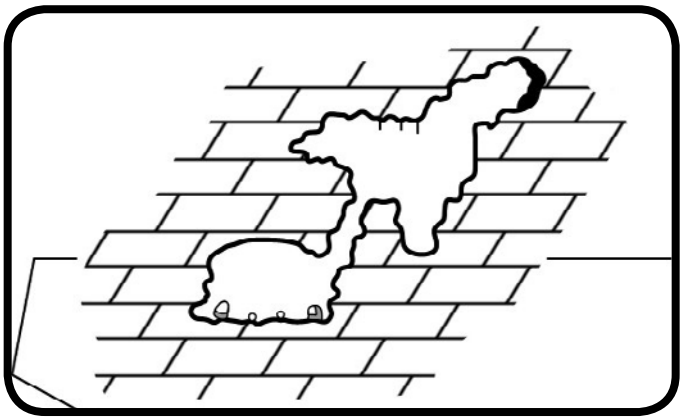
Conclusion.

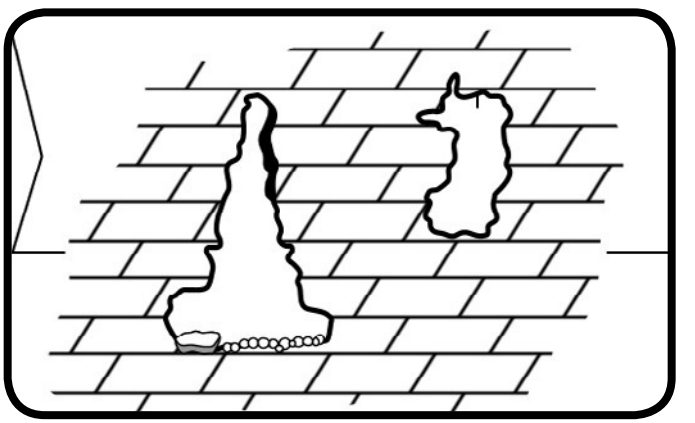
In summary, the best way to approach cross-sections is to go right for the throat; the more difficult they are, the more sorely they are needed. Good cross-sections not only augment a final map but engage its user, and the final product (composite or otherwise) is built on the shoulders of the individual cross-sections provided by each sketcher.

As discussed throughout this article, the cross-sections are incredibly important for several different reasons, and warrant the same level of attention and care as your plan view. It's tempting to just scrawl the outline of the passage here and there and move onward, but this short-changes the survey effort.

If you, too, suffer from Gutless Cross-Section Syndrome, make a conscious effort to draw them even in instances where you suspect it will be a pain in the ass, even if you already have two on that page and can't spare the room, even if it means you have to actually chimney up there to look and see where to draw that damned wall. The additional effort is worthwhile.

Page 45, top - this type of passage is too complex in character to adequately describe with a plan view, and the LRUDs are likely useless; Bottom - even reasonably simple composites showing two adjacent passages express a wealth of information about the cave's nature.





IN-CAVE SKETCH EXAMPLES USED IN THIS ARTICLE
Page 40 - J. Bartlett, Chinn Springs Cave, AR, 2009. Page 41, left - J. Bartlett, Mammoth Cave, KY, 2009.

DRAFT EXAMPLES USED IN THIS ARTICLE
Page 41, right - M. Sutton, Mammoth Cave, KY, 1992. Page 42 - J. Bartlett, South Fork Cave, AR, 2008. Page 43 - M. Sutton, Mammoth Cave, KY, 1992. Page 44 - S. House, Norris Cave, MO, 1986. Page 45 (both) - B. Miller, Barrow Cave, MO, 2007.

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2 *Be cautious, as often the LRUD dimensions provided do not reflect the absolute limits of the passage. In other words, it may be 3' from the station to the floor, but that doesn't mean the point below station is actually the floor's lowest point. A little BS detection here goes a long way.*