Survey & Cartography Session

Session Chair: Carol Vesely
Friday, June 17, 2022 Noon-5:00 pm
Location: Lions

The Survey and Cartography Session provides an opportunity for cavers interested in cave mapping to learn about new techniques, tools, and software related to mapping and cave surveying. Presentations may be on any topic related to any aspect of cave mapping such as: keeping cave mud off your survey instruments (while still going into the cave), resolving survey blunders, large project management, new tools for mapping or cartography, representing complex caves cartographically, comparisons of various programs for survey data processing, map drawing and data visualization, or integrating cave survey data with surface and GIS data.

Section Meeting/Session Schedule

Noon-1:15pm	Business Meeting	Lunch meeting of the Survey and Cartography Section
1:15 – 1:45	Bert Ashbrook	The Sarah Furnace Cave Survey
1:45 – 2:15	Philip Schuchardt	CaveWhere – From sketch to 3D cave maps
2:15 – 2:35	Derek Bristol	An Efficient Cave Cartography Workflow – Updating the Sistema Cheve Map
2:35 – 2:55	Zachary Normile	GeoSLAM LiDAR and Digital Elevation Models as a Tool for Georeferncing and predicting Subsurface Voids
2:55 – 3:10	BREAK	
3:10 – 3:40	Bill Koerschner	Experiment with Out-of-Cal DistoX
3:40 – 4:10	Philip Schuchardt	MapWhere – Offline Data Collection, Mapping and Synchronization App
4:10 – 4:30	Lee J. Florea and Sarah Asha Burgess	Illustrating the complexities of karst systems using geologic block diagrams
4:30 – 4:50	moderated by Carol Vesely	Open Forum: What's New in Surveying and Cartography

Survey and Cartography Session Abstracts
(listed in alphabetical order by main presenter)

The Sarah Furnace Cave Survey

Bert Ashbrook
caving.ashbrook@comcast.net

Sarah Furnace Cave is a maze cave in northwestern Pennsylvania. Joint-controlled passages form a dense grid of two- to three-feet high crawlways. With a density of 1.6 miles of surveyed passage per acre of surface area, it may be the densest cave maze on Earth. A vein of iron ore forms the ceiling of the passages, and 1860s miners enlarged some passages into stoopways by mining this ore. The 1950s, 1980s, and 1990s saw failed attempts to survey the cave. "Team Sarah" began the current survey in 2019 when the Mid-Atlantic Karst Conservancy purchased the property. To

attract surveyors, MAKC initially permitted only survey trips, and we trained sport cavers to survey. We obtained grants to purchase DistoX2 instruments, as Suuntos are difficult in tight crawlways. We conducted a day-long sketching seminar to help train new sketchers. To maintain enthusiasm, we survey as we go. Survey data is shared liberally. The working map is (usually) updated monthly. Friendly competition with another Pennsylvania cave survey has motivated both survey teams.

After the lockdown, we maintained two to three trips monthly through the COVID-19 pandemic by variously requiring masks, in-cave distancing, survey pods, vaccination requirements, and/or rapid testing as conditions changed. The cave forced other adaptions. We avoid putting stations on the iron ore ceilings. Each station is marked with a unique designation to aid both navigation and data reduction. Marked trails ease navigation through the maze. A rescue plan and cache are in place for lost cavers. We use a sign-in and out system and mandatory exit times. In our first three years, Team Sarah has made 90 survey trips, involved 106 different surveyors, surveyed over 5,000 shots, closed over 1,700 loops, mapped seven miles of cave, and left 120 leads remaining.

An Efficient Cave Cartography Workflow – Updating the Sistema Cheve Map

Derek Bristol
derekbristol@gmail.com

The workflow for taking cave survey notes and turning them into a finished map can be confusing and daunting for novice cartographers, and often overwhelming even for those with experience. Electronic sketch, digital data management software, and vector-based drafting tools have helped speed up the process. This talk will show one such process that was used to update the Sistema Cheve map in late 2021 following a year in which the cave grew from 55 km to more than 76 km in surveyed length. Sketches were collected both on paper as well as electronically in TopoDroid on Android tablets or phones. Data entry and compiling was conducted in Walls cave survey software. Drafting was completed in Adobe Illustrator. Detailed plan and profile view maps were drafted in only one month resulting in maps that serve multiple critical purposes including communication and outreach with local communities, study and understanding of the geology and hydrology of one of the worlds's deepest cave systems, and providing important visual tools for planning and executing future exploration objectives. An overview of the workflow used will be given along with some suggestions on ways to improve efficiency.

Illustrating the complexities of karst systems using geologic block diagrams

Lee J. Florea
mr_chaos@hotmail.com

Sarah Asha Burgess
sarahburgess00@gmail.com

Communicating complex geologic concepts to the public or other scientists can present challenges. For example, while the cave map is the foundation to karst science, making these maps accessible can be difficult. In addition concerns of propriety for resource stewardship and landowner relations, the intricacies of accurate cartography do not lend cave maps to easy annotation or interpretation.

Scientific illustrations, specifically geologic block diagrams, serve an important intermediary role in this communication by presenting a stylized portion of the cave in the context of surrounding landscape and hydrogeologic framework. Examples abound in the literature and are regularly employed for educational signage. The accuracy in scale, layout, and detail of these illustrations is tailored to the needs of the author and audience on one hand balanced against the limitations of the resource manager on the other. This presentation is not about cartographic rendering of data. Rather, we use examples of mapped caves, or amalgams of multiple caves and translate those into block diagrams appropriate for scientific publications intended for audiences in geochemistry, hydrogeology, geomorphology, and glaciology. We demonstrate the process from initial concept through final figure production, including hand sketching, computer vectorizing, careful stylizing, and suitable colorizing to achieve a product to communicate the original intent.

Experiment with Out-of-Cal DistoX

Bill Koerschner
wkoerschner@msn.com

In an ideal world, all DistoX cave surveys would be done with a freshly calibrated instrument. Unfortunately, cavers are lazy, so most surveys are done with an instrument whose calibration is accepted as 'probably good enough'. An experiment was designed to compare the various methods of shooting DistoX to determine 'best practices' for obtaining data with an 'out-of-cal' instrument. A loop course of 8 stations (246ft) and a linear course of 12 stations (420ft) were laid out. Both courses were shot with Suuntos / fiberglass tape and with three out-of-cal DistoX. The DistoX were shot double Frst/double Bkst in each orientation (display up, display down, display left and display right). The DistoX shots departed from analog shots by as much as 4 degrees. The data were processed using Walls cave survey software. The shots were then combined in various ways to examine the effects of survey methods on closure of the loop course and deviation from the analog survey on the linear course. All of the DistoX surveys had as good or better vertical closure than could be obtained with Suuntos, so we can conclude that calibration drift has no effect on inclination. The horizontal closures ranged from 2.2ft to 9.9ft. Averaging Frsts with Bksts dramatically improved loop closure but only when Frst/Bkst pairs were shot in the same orientation. The method of averaging a display-up / display-down Frsts was fairly effective at cancelling out calibration drift but not as good as collecting Bksts. Cherry-picking orientations in the cave to obtain better Frst/Bkst agreement makes the closure worse. Recommended best practice is to use only one instrument, shoot everything in display-up orientation and average Frsts and Bksts.

GeoSLAM LiDAR and Digital Elevation Models as a Tool for Georeferencing and Predicting Subsurface Voids

Zachary Normile
zachary.normile@uga.edu

Karst conduits (e.g., caves, caverns, voids) are naturally difficult and often dangerous locations to access and research, especially using the large or delicate pieces of equipment that are often required. Current methods for mapping these underground features rely on geophysical tools that are expensive and imprecise. In partnership with the Southeastern Cave Conservancy (saveyourcaves.org), this study tests the feasibility of using GeoSLAM LiDAR equipment and software to map cave interiors in 3D and relate formations to surface topography in the 10-km Tumbling Rock Cave, located in the Cumberland Plateau region of Northeast Alabama. Digital elevation models (DEMs) and LiDAR images are used to identify landscape features (e.g., depressions, lineaments) that could be indicative of subsurface voids. The two goals of this investigation are to use this information to manage risk pathways to cave- and ground-water

contaminants and to predict the presence of karst conduits based on topography. GeoSLAM LiDAR has been shown to be an effective method of mapping karst conduits in relation to surface features, but its viability as a predicting tool has not yet been proven. Future applications of this research could include predicting sinkhole formation before they form and estimating air and groundwater storage of caves.

CaveWhere® – From sketch to 3D cave maps

Philip Schuchardt
vpicaver@gmail.com

CaveWhere, intuitively designed survey software, enables building and visualizing underground cave maps. Using its advanced 3D engine, CaveWhere automatically morphs 2D cave survey notes into a 3D visualization using a three-step process. First, the cartographer imports or enters centerline survey data. Second, a scrap is registered by creating a polygon around a section of survey notes and entering survey stations. Finally, the registered scrap is morphed and rendered in a 3D view with a process called Carpeting. Once Carpeted, cartographers can export the 3D rendering using the combined plan, running profiles, and projected profiles into a 2D map for drafting a final cave map.

MapWhere – Offline Data Collection, Mapping, and Synchronization App

Philip Schuchardt
vpicaver@gmail.com

All caving expeditions are limited on time, constrained by the season or time-off. Knowing exactly where cavers have been, and what they found, directs future ridge-walking efforts. As soon as a caver adds a track or creates a waypoint, the team's dataset is stale. Without the internet, the team can't synchronize new data. MapWhere is a phone mapping app, that allow teams to synchronize waypoints and tracks, offline, and in the field. New team members need to download the app before the trip. Once in the field, the trip leaders can give them access to the data through MapWhere's NoNet device. NoNet is a tiny, 23g computer with an expandable SD card and Wi-Fi network. Ridge walkers then enter new data in customizable layers, specific for your project. If you accidentally destroy the NoNet device, don't worry, your team can synchronize with the cloud after the trip. Unlike other mapping apps, MapWhere supports custom fields, layers, base maps, and can keep your team up to date, in the field, without the internet.

What's New in Surveying and Cartography?

Moderated by Carol Vesely
cavesely@gmail.com

In this informal, open forum, everyone is invited to share. It's been three years since our last full in-person NSS convention so let's talk about new adaptations, techniques, and equipment pertaining to cave surveying and cartography. Some possible topics are: How did you manage your survey project during COVID? Did you tackle learning to draft maps with Therion during lockdown and what plusses and minuses did you encounter? Have you tried the new BRIC4 survey instrument and compared it with the DistoX2? There are many other possible topics. Please bring any new equipment and ideas you have to share.

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