



THE SPELEOGRAPH

Lake Ozarks Grotto
Volume 54 Issue 2
July – December 2023



The astonishing beauty in a Missouri cave

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Saint Louis University students sample the Cliff Cave system near St. Louis, Mo

Researchers find high concentrations of microplastics in cave water and sediment

by Jacob Born, Saint Louis University

In two recent papers, Saint Louis University researchers report finding high concentrations of microplastics present in a Missouri cave system that had been closed to human visitors for 30 years.

Elizabeth Hasenmueller, Ph.D., associate professor of Earth and Atmospheric Sciences and associate director of the WATER Institute at SLU, and her team published findings in the journals, *Science of the Total Environment* and *Water Research*,

finding significant microplastic levels in Cliff Cave in Saint Louis County, Missouri. The research, which originated from Hasenmueller's research group and Karst Hydrology class, allowed students on the team to participate in field research and publish their findings.

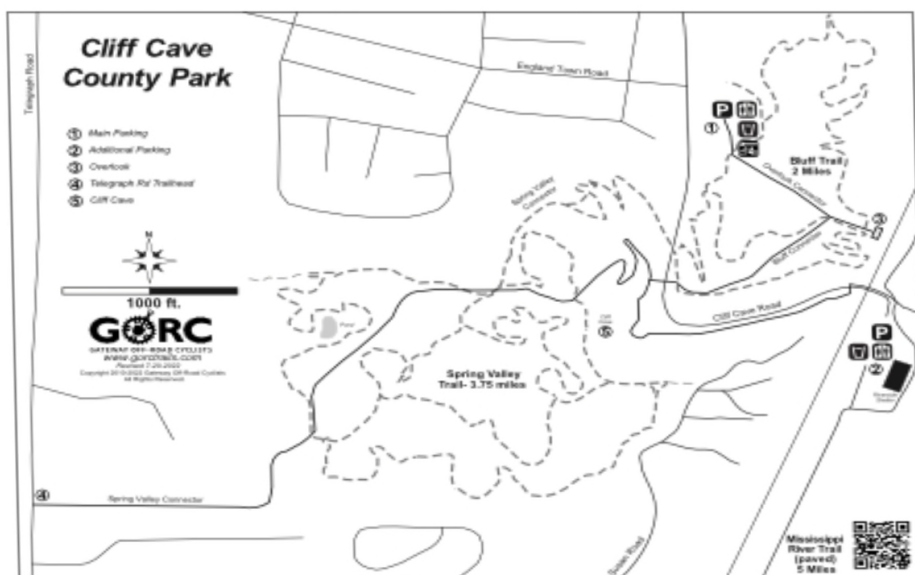
Microplastics are characterized as plastic particles smaller than 5.0 millimeters and can be found across marine, terrestrial, and freshwater environments. Hasenmueller has previously studied microplastics in river systems, such as the Meramec River basin, but now wanted to look at the subsurface, an area that has not seen much research at all.

“A lot of research has been focused on surface water settings,” Hasenmueller said. “Microplastics research initially started in the ocean because of the highly visible problem of large plastic pollution in this environment. Recently, more research efforts have gone towards examining rivers, lakes, and other surface freshwater systems.”



Cliff Cave entrance

However, one of the most understudied areas in this field relates to what's happening to the subsurface in terms of microplastic contamination. These particles could be getting into groundwater, a common drinking water resource, or caves, where fragile ecosystems exist. During the last few years, my research team has been focused on trying to understand microplastic prevalence and transport in these subsurface environments." Hasenmueller and her team selected Cliff Cave for their studies as the cave has been closed to the public since 1993, allowing them to eliminate human presence in the cave as a possible cause of any observed microplastic contamination. Their research showed microplastics were found throughout the cave, but the highest concentrations were located near the entrance and in sediment.



"Part of the reason we picked Cliff Cave is because St. Louis County Parks regulates access to the cave," Hasenmueller said. "We knew if we found microplastics in the cave, it's not going to be because somebody has just hiked back into the cave and shed fibers from their clothing or left food wrappers."

Through their research, Hasenmueller and her team discovered that flooding increases the amount of microplastics moving through the cave system. Microplastics move with water, and when flooding occurs, the excess water brings more microplastics with it to the cave.

Flooding also contributed to a higher diversity of microplastics in the cave water. When those flood waters receded, microplastics were likely deposited near the cave's mouth in higher abundances than in locations deeper in the cave.

"We weren't sure what to expect with the dataset, but we found that the cave's main entrance is where there's a lot of microplastic debris, either from flood deposition or possibly from microplastic particles suspended in the air being deposited near the opening of the cave," Hasenmueller said.

"We know for sure that floodwaters are bringing microplastics into the cave because as we were traversing the cave passages and collecting samples, we found a plastic chip bag that was intertwined with leaves, acorns, and other flood debris from the surface."

Not only did flood waters contribute to higher levels of microplastics, but Hasenmueller and her team also found that microplastics were almost 100

times more concentrated in sediment than in the water found in Cliff Cave. Microplastics were deposited into the cave's sediment by the cave's stream water and remained there even after the flood water receded.

"We were trying to figure out what fraction of the microplastics are actively moving through the cave stream right now versus what's being stored long-term in the cave's sediment," Hasenmueller said. "One of the really interesting things we found is most of the microplastics were in the sediment. So, 99 percent of the microplastic debris we found in the cave was stored in the sediment; only a very small fraction of the plastic was in the water."

"As the water levels go up during a flood, you see higher abundance and diversity of microplastic particles in the water," Hasenmueller added. "We think what is probably happening is that after the cave floods, particles in the water are deposited into the sediment. As the waters recede, that material remains in the cave sediment, potentially for decades or longer. And when the water level goes down, microplastic concentrations in the water are much lower."

Despite being blocked off from humans, the cave still feels their impact. Cliff Cave is located near residential areas that could be contributing microplastics to the system, a finding that aligns with previous research by SLU's WATER Institute showing that population density is the biggest factor determining where microplastics are found in nature. Hasenmueller said with these findings, there are some things people can do to limit the amount of microplastics they may be contributing to the environment.

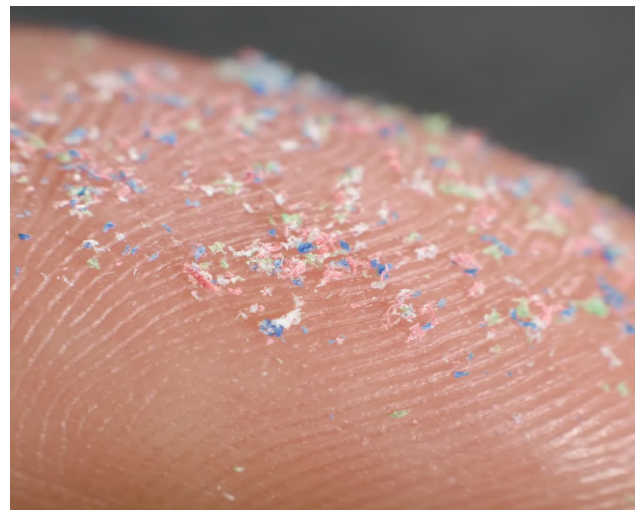


Water flowing from the Cliff cave system

"It's hard for us as individuals to deal with plastic pollution because of the pervasiveness of these materials, but it helps to be mindful of your personal plastic use," Hasenmueller said. "Individuals can avoid buying plastic materials like synthetic textiles used in clothing, but doing so presents challenges to everyday consumers. On a larger scale, we, as a society, could move away from synthetic clothing, because a lot of the debris that we found in this cave was synthetic fibers from textiles. And of course, reducing our overall plastic production and consumption would help as well."

Microplastics not only potentially do damage to the cave environment, but they also affect wildlife that call Cliff Cave home. Bats, amphibians, and other animals move freely throughout the cave, and microplastics could disrupt their delicate habitat. Microplastics are not just a human problem, but also an environmental problem, and Hasenmueller calls for more research to ensure the contamination does not become worse.

"Understanding what level of threat microplastics pose to the unique and rare animals that only inhabit cave systems is really important," Hasenmueller said. "Only a handful of studies have assessed microplastics in these types of underground ecosystems. So, our work provides resource managers with the information they need to be thinking about to protect these fragile habitats from emerging contaminants like microplastics."



The Magic of Ha Ha Tonka

There are many places in the Missouri Ozarks noted for beauty, intrigue, romance and history but to have it all in one place is pure magic! At Ha Ha Tonka State Park the natural wonders and curiosities are blended with cultural artifacts in a most unique way. People who discover this gem of springs, sinkholes, natural bridges, caves, cliffs, woodlands, glades, savannas, hills, hollows, lakes, trails, boardwalks, outlaw history and the ruins of a spectacular castle and carriage house usually return again and again.



Aerial view of Ha Ha Tonka park

Missourians have made it one of the state's most treasured parks. It is located on the Niangua Arm of Lake of the Ozarks where Daniel Boone and his son Nathan once trapped beaver and the Osage

Indians lived, and it's less than two miles west of Camdenton off U.S. Highway 54 on D road.

The park is so popular that no matter how cold, hot, wet or dry the weather is, you can almost always find someone wandering about in this remarkable park totting a camera, admiring the scenery, viewing the castle, fishing down by the lake, having a picnic or simply sitting on a bench enjoying the outdoor setting. Yet far too many people who visit the park leave thinking they have seen it all when they have visited the castle ruins, looked into the entrance of River Cave, walked beneath the Natural Bridge, peered at the Water Tower, circled the old post office building or hiked the trail in the great Chasm to visit the spring that issues forth 50 million gallons of cold ground water every day. Only a small percentage of visitors take on the challenge of exploring the trails that radiate elsewhere throughout the several thousand acres of the park. Marvelous things are tucked away in those backwoods areas along the outbound trails of Ha Ha Tonka. The park has 15 miles of trails but you don't have to hike to the bitter end of every trail to find something interesting.



Ha Ha Tonka natural bridge

When you visit River Cave do more than just peer into its main entrance and its sinkhole. Go around the boardwalk that leads down to the cave's entrance and view the other sinkhole – the one that features a second gated entrance to the cave. It's one of the deepest

and most impressive sinkholes in the park. If you are there after a heavy rain you might find it exciting because the sink can become a deep lake with a sucking whirlpool sending storm water into the cave.

And if its June or July, just a short jaunt away is one of the park's most beautiful glades with abundant wildflowers.



Ha Ha Tonka Spring

The name “Boulder Ridge” should clue you in to the character of this easy one-mile hike but the surprise is that the boulders aren’t exactly on the ridge since they have taken a tumble part of the way down the south slope of the ridge. And they are huge.

One of the more scenic bluffs in the park is tucked away along the Devil’s Kitchen Trail. Here, along the east wall of a broad sink valley is a towering, curving wall of dolomite, hence the name “Promenade.” Associated with it is a larger shelter cave called “The Devil’s Kitchen” and at the back of the boulder-strewn cave is a skylight where smoke from the devil’s fireplace probably escaped.

Out upon the ramparts of the Dolomite Rock Trail are Witness trees, a mysterious man-made rock wall, and an outcrop of Gunter Sandstone unlike any other in the park. You can explore along the

base of the sandstone ledges for nearly one-quarter mile and find plenty of odd, grotesque, colorful and scenic features to examine and photograph. The day the author hiked the trail another hiker was encountered, a gentleman who said he'd hiked the Dolomite Rock trail many times and rarely ever saw anyone upon it. He seemed surprised to encounter me. And I was surprised at the natural wonders I found along the Dolomite Rock Trail. My camera stayed quite busy.

If you've never seen a fault in the earth where the powers of mother nature deep underground have disrupted the bedrock and pushed it to the surface to leave it tilted at a sharp angle and mounded up as if a giant mole has tunneled the landscape, then take a hike on the Turkey Pen Hollow Trail where wildflowers blaze in season. The Red Arrow Fault is about two-and-a-half miles out and the trail crosses right over it.

Dwight Weaver
Published summer 2011

Turkey pen hollow trail at Ha Ha Tonka Park



PROJECTS NEW AND OLD

INITIALLY, SEVERAL ambitious projects were begun by LOCC members and detailed in the first issue of the club publication. Unfortunately, the execution of this work has been delayed, re-channeled or foregone for various reasons.



Stark Caverns

PROJECT DIG:

Started at Dry Cave along the Big Niangua. This project has been abandoned as a club project but some work at the cave was carried out in the spring or 1971 by Karen Weaver and Dwight Weaver. Originally, Kent Buehler and Dwight Weaver electrically lighted the cave to facilitate the work.

PROJECT AUGLAIZE:

Begun in November of 1968 to locate a large cave system believed to exist east of Carroll Cave.

When organized, LOCC had a decided interest in archaeology. Since 40% of the membership were archaeology buffs. Such interest has virtually disappeared since 1969. The club's most noted past member archaeologist, Kent Buehler, is now one of the state's professional archaeologists. The excavation at Stark Caverns several years ago is a fine tribute to Kent.



Carroll Cave

The Speleograph

Project directors at that time were Bill Saltz, James Phillips and Dwight Weaver. Dave Sandlin and Jerry Leap have since assumed these responsibilities. During 1971 several trips were made to the area and useful information gathered. The project will be continued whenever possible.

CAVE LOCATION: To facilitate the location of caves in Miller, Morgan, Benton and Camden counties, an extensive summary listing was published in January of 1969 for LOCC members.

Since that time new caves have been located and recorded for each of the counties mentioned except Benton.

MORGAN COUNTY CAVE SURVEY: Morgan county had, in 1969, only 13 recorded caves. A survey of the county was initiated by Ross Hurley and Morris Hall in 1970. As a direct result of their work, the number of recorded caves for Morgan County now exceeds 40. Surveying of the caves is underway and most have already been reported for the M.S.S. files.

CAMDEN COUNTY HISTORY, CAVES: Missouri Speleology, Vol. 11, No. 1-2, a history of Camden county caves known and under water. Written by Dwight Weaver. Also, in spring of 1972, ADVENTURES AT MARK TWAIN CAVE, a 64,page illustrated history of Mark Twain Cave written and published by Dwight Weaver and Paul Johnson.

-Dwight Weaver-



Breakdown

Gary Zumwalt - What kind of wine was in that bottle?

Christen Easter - Jesus wine - he turned it into water!

Gary Zumwalt - What is the name of the bat in your pocket?

Christen - Cecil....

When asked by Chairman Long to keep the grotto's Facebook page updated and to schedule programs for grotto meetings, Christen's reply - But, I work.....

Ken Long - I was just too excited, singing "Like a Virgin".....

Ken Long - You never know what you might catch at my house...

Christen Easter (when asked if she was speeding to get to the meeting on time) - 9 - you're fine, 10 - you're mine.....

Buzz Caldwell - You might as well try to urinate up a rope....

Buzz Caldwell - I don't have a phone..

Ken Long - I might have a smart phone but a dumbass is using it.....

Christen Easter - Tea is just dirty water...

Karen Weaver about Rosie Weaver - She reads the newspaper from cover to cover, I skim it...

Christen Easter - That's been a hot minute....



July 11th, 2023

The July meeting of Lake Ozarks Grotto was called to order by Ken Long, Chairman, in the meeting room at Stark Caverns, Eldon, MO.

Roll Call: Seven members present – Christen Easter, Ken Long, Linda Marg, Karen Weaver, Rosie Weaver, Gary & Alberta Zumwalt.

The minutes of the June meeting were read and approved.

Chairman Long had talked to Chaz Jesiolowsky about interest in remaining a member of the grotto. He said he didn't have the time to come to meetings because of his job. So, he will be taken off our roster.

Kiesewetter – Chairman Long is waiting for a cooler day to put the gate in the fence at the cave's parking area. He has the gates and the adjoining landowner intends to do most of the work. Chairman Long said he will be taking a group into the cave which will include a new landowner.

Goodwin. Chairman Long said that Klaus Leidenfrost had done some weed eating at the site and hopes to get some big machinery to the site to do some more work.

Miller Co.- Discussion on caves in Miller Co. Will see if Buzz will do his presentation at the August meeting. A list of the caves that need GPS locations and entrance pictures was discussed. That is something that our grotto can work on. The place along the highway just past Old Kinderhook was determined to be Roadcut Cave, Camden Co.

Facebook – Christen is in charge of keeping the grotto's Facebook page current. Chairman Long has asked her to take care of that and getting presentations for the grotto meetings.

Meeting adjourned. – Respectfully submitted, Alberta Zumwalt

August 8th, 2023

The August meeting of Lake Ozarks Grotto was called to order by Ken Long, Chairman, in the meeting room at Stark Caverns, Eldon, MO.

Roll Call: Seven members present – Buzz Caldwell, Christen Easter, Ken Long, Karen Weaver, Rosie Weaver, Gary & Alberta Zumwalt.

The minutes of the July meeting were read. Correction to the minutes: Roadcut Cave is not the cave close to Kinderhook as stated in the minutes. The minutes were approved, with the correction.

Kiesewetter Cave – Chairman Long reported waiting for better weather to install gates.

Chairman Long led discussion on Sara Cave and Flanders Cave in relation to Stark Caverns. Sara Cave has a critter in and cannot be accessed at this time.

Goodwin – Chairman Long reported that he, along with Klaus Leidenfrost and Jean Knoll worked on mowing, etc. Lots of mud in the entrance.

The secretary has the sweatshirt that member Craig Smith had bought. Craig's sister wanted the grotto to have it back since he never got to wear it. It was decided to use it as a Xmas party prize.

Meeting adjourned. – Respectfully submitted - Alberta Zumwalt

Following the meeting, Buzz gave an informative presentation on caves in Miller Co., with topo maps and cave maps.

September 12th, 2023

The September meeting of Lake Ozarks Grotto was called to order by Ken Long, Chairman, in the meeting room at Stark Caverns, Eldon, MO.

Roll Call: Seven members present – Buzz Caldwell, Christen Easter, Ken Long, Karen Weaver, Rosie Weaver, Gary & Alberta Zumwalt.

The minutes of the August meeting were read and approved.

Ken Long checked along Hwy 54 near Old Kinderhook and reported no caves.

Goodwin. Klaus Leidenfrost, Jean Knoll and Chairman Long mowed grass, trimmed trees and did routine maintenance at the site. Chairman Long said that there will probably be no more work trips on the Goodwin project and that Klaus is planning on turning in his management. Planned trips will be for maintenance of the area, only.

Discussion on Miller Co. caves with past reports on caves read. A number of past members need to be contacted to get more info on some of the caves.

Kiesewetter. Chairman Long reported the gate is still in his yard. Trips into the cave are scheduled for the 23rd & 24th – KC and MCKC. Chairman Long wants to take a trip in. Christen said she would go and Buzz is interested in going.

Xmas party – Christen volunteered to host the party on Saturday, Dec. 2nd with the same times as last year – starting at 1:00, eat at 2:00. Chairman Long's birthday is on Sunday, Dec. 3rd.....

Meeting adjourned.—Respectfully submitted, Alberta Zumwalt

October 10th, 2023

The October meeting of Lake Ozarks Grotto was called to order by Ken Long, Chairman, in the meeting room at Stark Caverns, Eldon, MO.

Roll Call: Six members present – Christen Easter, Ken Long, Karen Weaver, Rosie Weaver, Gary & Alberta Zumwalt.

The minutes of the September meeting were read and approved.

Goodwin. Some discussion on the policy that MCKC requires a paper to be signed online for anyone that goes on MCKC property. Those attending the MSS meeting weekend at Berome Moore all had to sign the paper. Chairman Long did not know if Klaus Leidenfrost had turned over the management of Goodwin to MCKC.

Kiesewetter. Ken Long reported that his planned trip to the cave had fallen through.

Next month will be election of officers and Xmas party sign-up.

Discussion on Bridal Cave's anniversary celebration with ticket prices being the original price for one day.

Laclede Co. caves. The secretary sent three letters to former members about caves that were listed in Speleograph reports years ago but never recorded – Doug Feakes, Jim Travis and John Linquist. So far, only John has responded. He will be returning to Missouri in March to plant trees on his property here and is willing to meet with grotto members to see if we can find the caves.

Meeting adjourned—respectfully submitted, Alberta Zumwalt

November 14th, 2023

The November meeting of Lake Ozarks Grotto was called to order by Ken Long, Chairman, in the meeting room at Stark Caverns, Eldon, MO.

Roll Call: Seven members present – Buzz Caldwell, Christen Easter, Ken Long, Karen Weaver, Rosie Weaver, Gary & Alberta Zumwalt. We had one guest, Matt Naughton, General Manager of Stark Caverns.

The minutes of the October meeting were read and approved.

Xmas Party – At the home of Burke & Christen Easter on Dec. 2 nd . Start at 1 pm, eat at 2 pm, with games and prizes. A food sign-up sheet was passed around.

Goodwin – Chairman Long led a discussion and explained the project to our guest.

Kiesewetter – Chairman Long has been manager for 20-plus years. The gate on the property might be installed during Thanksgiving week. Chairman Long said that a Chouteau group went in on Oct. 21 st and thought they found unmapped passage.

Election of Officers – The current officers were re-elected for the coming year, something about doing it until we got it right.....

MSS Meeting – Gary gave a short report on the Fall Meeting, held at Berome Moore property. Cole Co. cave – Gary got a GPS reading and pictures of Sunrise Shelter in Cole County for the cave files. He had turned in the location and a map many years ago.

Miller Co. caves – Buzz talked about Klug's Cave near Mary's Home, down 10-mile Dr.

Meeting adjourned. —respectfully submitted, Alberta Zumwalt

LOG Christmas Party – 2023

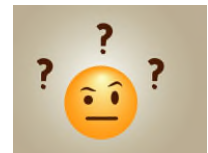
This year's annual Christmas party for Lake Ozarks Grotto was held on December 2nd at the home of Burke & Christen Easter, where the party has been held since 2009. A big thank you for hosting the party for so many years and allowing us to return for another year. Our group seems to get smaller every year. The loss of five of our members within the last couple years, plus most of us getting old, has taken a toll on our grotto.

Gary & I arrived with Travis & Kathy. It wasn't long before others started to arrive. We had a total of 12 people in attendance. Others in attendance were: Frank Hurley, Ken & Monica Long, Rosie & Karen Weaver and Derek Zumwalt.



In line getting ready to eat. From left to right is Frank Hurley, Ken Long, Derek Zumwalt, Burke and Christen Easter and Kathy Zumwalt.

Christen had baked a whole turkey since Burke said he wanted leftovers. We definitely had plenty of food. Ken brought his usual Habanero jelly, cream cheese & crackers. Burke did a fine job of carving the turkey. Everyone else brought dishes to add to our buffet. Gary had baked some special Swedish cookies, a recipe that was brought back from our overnight bus trip to Branson in November. I asked Ken if he liked them and told him the name of the cookies – Swedish Pepparkakor (pronounced like peppercoker) and I think it was one of the few times that Ken has been left speechless! I could see his mind working but nothing was coming out of his mouth.....



The Speleograph

Ken thanked Burke & Christen for hosting the party. I presented Ken with his gift of hot sauces. For the door prize, each person took a card from a deck of cards. The first card that I called, was the winner – Burke.

Instead of the dice game that we did for several years, we did the left/right game, which had previewed at the 2021 party. Small gifts were passed out to each person. I read the story while participants sent their little gifts left and right as the story called for. The story was even longer than last year. And there might have been some confusion as to what was right and what was left! At the end of the story, everyone got to keep the gift they had ended up with.



Filling our plates

Next was Cave-O. I called out the words with less heckling than usual. I couldn't help but think that we were missing Dwight, Bill, Kerry, Bob and Craig. Bob and JoAnne had intended on attending the party last year but decided not to come at the last minute – and he was gone right after that..... Craig Smith had attended last year – it turned out to be his first LOG party and his last.

Playing Cave-O



We played three games of regular Cave-O with the winners being: Christen (2), Derek (2), Karen, Kathy, Ken, Rosie and Travis. We did a black-out game with 4 winners: Burke, Karen, Monica and Rosie. The winner of the coveted bat spatula was Rosie. Frank didn't win anything and was given a prize. Everyone was given a choice of a red or green pencil with bats on it. The prizes were donated by Ken & Monica, Rosie & Karen and Gary and me.

Everyone gathered up their stuff and headed out the door. It had been a good party with lots of good food and conversation. And

Burke had leftovers!

We don't know what is ahead for the future of our grotto but we will take it one year at a time. – Merry Christmas & a very Happy New Year to all! – Alberta Zumwalt