Cave Researchers Descend into the Depths with the TROLL® 9500 Water Quality Instrument

Researchers profile four pools in the Lechuguilla Cave in Carlsbad Caverns National Park

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Overview

Research of cave pool stratification may help scientists understand the geochemical origin and evolution of cave pool waters (Levy 2008). Dr. David Levy conducted a study to test the hypothesis that certain cave pools may be predisposed to a condition of permanent chemical stratification (meromixis), depending on the specific effects of pool morphometry and localized environmental conditions. Levy and his team organized a week-long caving expedition to study selected pools in Lechuguilla (pronounced *lech-uh-GEE-yah*) Cave, New Mexico. Lechuguilla Cave is the deepest limestone cave in the United States and contains over 200 km (> 125 mi) of passage.

Down in the Depths

Levy's team profiled four pools in Lechuguilla Cave, situated at depths ranging from 221 to 439 m below the ground surface (see Figure 1). Compared to the hundreds of other pools within the cave system, these pools are relatively large and deep. During the summer of 2007, Levy and his research team profiled the following pools:

- Lake Chandalar at -221 meters (-725 ft) below ground surface
- Lake of the Blue Giants at -277 meters (-909 ft)
- Lake Margaret at -310 meters (-1,017 ft)
- Lake of the White Roses at -439 meters (-1,440 ft)

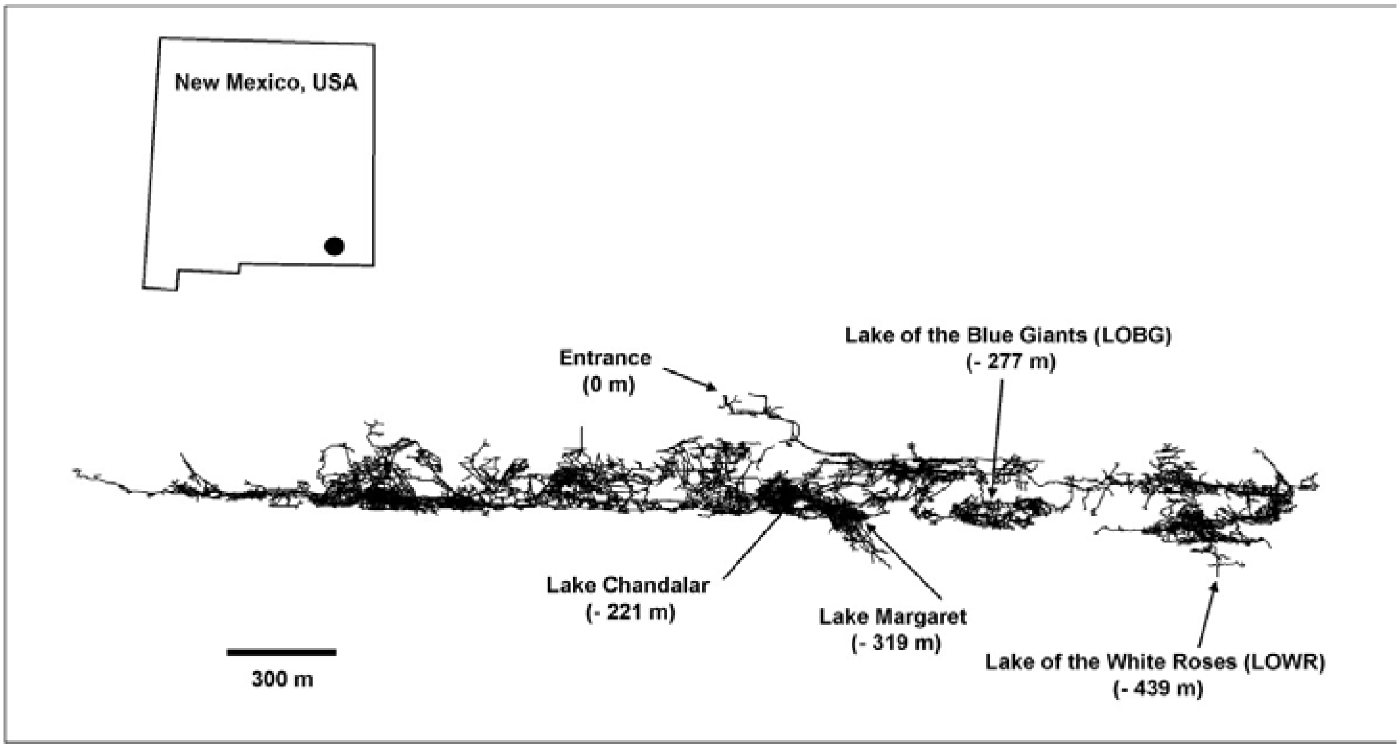
Levy also chose Lechuguilla Cave for the study because it contains many isolated pools with varying chemical

Levy, shown here, and research teammates descended to the deepest point in Lechuguilla Cave (1,440 ft below ground) with the TROLL 9500 during their eight-hour trip to Lake of White Roses. Photo taken by and courtesy of Pat Cicero.

compositions. Various factors contribute to each pool's chemical composition – bedrock mineralogy, localized evaporation rates, and the amount of time the water remains in the pool before continuing through the hydrological cycle (residence time) (Forbes 2000; Turin and Plummer 2000). The isolated pools provided Levy with a unique setting for studying chemical stratification in fresh water pools within a limestone cave.

Pool Sampling Logistics

Reaching the entrance to Lechuguilla Cave requires hiking several miles across a remote area of Carlsbad Caverns National Park. Access to the study areas then requires up to an entire day of technical, vertical caving to reach the most remote cave pools.



Map of Lechuguilla Cave (profile) shows the entrance and locations of the pools sampled by Levy's team. Survey data provided by Carlsbad Caverns National Park, August 25, 2007.

To profile the cave pools, Levy choose the multiparameter TROLL® 9500 water quality instrument. This compact instrument eliminated the need for packing several single-parameter instruments.

"We could standardize the sensors before we entered the cave, and count on them to be stable and ready to work several hours later," said Dr. Levy.

On the eight-hour descent to the Lake of White Roses, scientists needed to move quickly and be relatively unfettered by gear. Levy reported that each team member carried part of the TROLL 9500 system during their exploration. The multiparameter instrument allowed Levy to measure pH, specific conductivity, ORP, temperature, and dissolved oxygen at every foot, for 15 feet, in about 15 minutes (see Figure 1).

"The TROLL 9500 system was easy and quick to assemble when we finally reached the pool," Levy reported. "We measured key parameters at Lake of White Roses, which is almost 1,500 feet below Carlsbad's surface and has been shown [recent hydrologic studies now prove this] to be a window on the regional Capitan Aquifer.

"We particularly wanted good at-depth dissolved oxygen measurements so that we could compare data from cave pools to data from deep wells in the region," Levy said.

Levy explained that such data could help scientists determine if the Lake of White Roses represents the maximum air-filled depth – the deepest point – of the deepest cave in the United States.

"The instrument had more than ample power to conduct all of our testing, and the software was easy to use," Levy said. "This left the team with time and energy for their long ascent back to Carlsbad's surface."

Researchers Deepen Understanding

After evaluating the chemical profiles of the four Lechuguilla Cave pools, Levy found that both transient atmospheric and mixing of waters with contrasting salinities may be responsible for chemical stratification in cave pools (Levy 2008). By profiling chemical composition at different depths within each pool and by measuring atmospheric carbon dioxide and barometric pressure, scientists may be able to distinguish atmospheric surface effects from mixing of waters as the cause of chemical stratification in some cave pools (Levy 2008).

Cave researchers deploy the TROLL® 9500 instrument at Lechuguilla Cave's Lake Margaret. Researchers use the RuggedReader® handheld PC to view data while profiling the lake. Photo courtesy of David Levy.

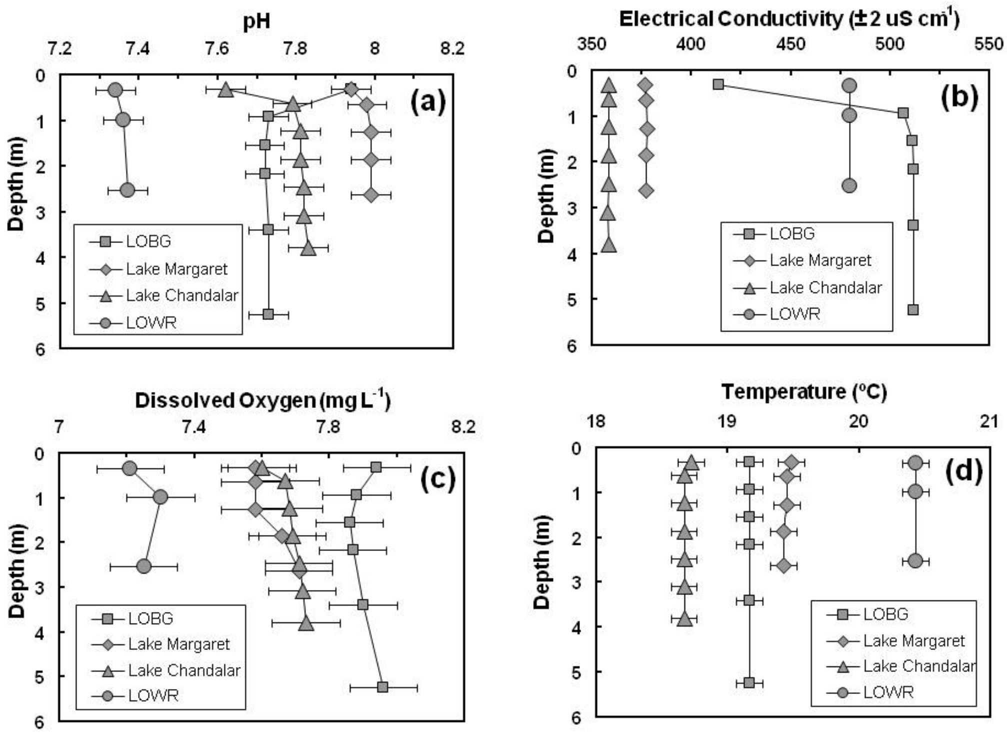


Figure 1. Chemical profiles for pools studied: (a) pH, (b) electrical conductivity, (c) dissolved oxygen, and (d) temperature. Error bars represent the accuracy of measurment for each TROLL 9500 sensor.

Getting to Lake Chandalar in Lechuguilla Cave, 725 feet below the surface of Carlsbad Caverns National Park, took the research team about three hours of rope descents and technical caving. At the pool, Levy used the profiling mode of the TROLL® 9500 instrument to record data as the instrument moved through the pool's strata. He used the RuggedReader® handheld PC to view water quality data measured by the TROLL 9500. Photo taken by and courtesy of Kristen Levy.

To learn more about this study, read Levy's paper – An Investigation of Meromixis in Cave Pools, Lechuguilla Cave, New Mexico – published in the *International Journal of Speleology*, July 2008 (download the paper: http://www.in-situ.com/products/Water-Quality/TROLL-9500-Instruments/TROLL-9500-Water-Quality-Instrument/resources).

Resources

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