

# Blue holes a mystery of the deep

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On the long list of reasons why few scientists have dared plumb the mysteries of the Bahamas' famed blue holes, the toxic swamp gas actually rates pretty low.

Hydrogen sulfide gas, a byproduct of bacteria and plant debris rotting for eons, gets trapped in a murky zone called the halocline where dense salt water mixes with fresh rain water floating above. In some submarine caverns, swimming through the foul layer leaves divers with burning skin, retching stomachs or worse.

That says a lot about the daunting challenges below: utter blackness, uncharted and claustrophobic passages, walls that crumble into clouds of silt, shifting currents and extreme depths that demand exotic diving gear, elaborate safety systems and Zen cool.

For Kenny Broad, a University of Miami scientist who led a National Geographic Society-backed expedition that made 150 dives into blue holes on Abaco, Andros and other islands, the rewards far exceeded the risks.

The team, composed of expert cave divers and researchers from the University of Miami, the National Museum of the Bahamas, Florida Museum of Natural History and other universities, emerged from the dark caverns with findings that could shed new light across fields from natural history to microbiology to climate change.

"These holes are a time capsule of evolutionary science," Broad said.

"They're a modern-day window into what it was like millions of years ago."

Starved of light and oxygen that typically fuel decay, the blue holes have produced an array of stunningly preserved fossils, from brown bones of ancient native Lucayans to shells of long-extinct land tortoise and freshwater crocodiles once thought to live only in Cuba.

The caverns are also places of weird life and other-worldly beauty, a combination that put the expedition on the cover of August's National Geographic.

The holes are populated by blind cave fish, strange and tiny crabs and shrimp and masses of microbes, including never-before-seen "extremophiles" adapted to survive the harsh environment. Ancient fossilized reefs form the walls and some passages are labyrinths of gnarled but fragile stalagmites that can evaporate in puffs of silt if struck.

"It's not buried gold but it's really a treasure," said Nancy Albury, the project coordinator for the Bahamas' national museum, which supported much of the earliest research on the caverns and helped fund the expedition. "It's telling us an amazing story."

Peter Swart, a UM professor and geochemist, found a geological calendar of climate change in the buildup of sediments that shaped the stalagmites. The caves were formed during past ice ages, when rain leached into exposed limestone carving the caverns and creating the stalagmites. As the earth thawed, the rising sea filled the caverns.

Because the Bahamas are isolated far from the influence of river deposits, Swart said the blue holes' stalagmites are ideal for studying atmospheric changes. The formations show huge swings in sea level and

spikes in iron from African dust, suggesting intense periods of drought, he said.

"There was some variation, but generally speaking sea level has gone up 300 to 400 feet in the last 20 million years," he said. "It was much higher in the past than it is at the present time."

Broad, an assistant professor of ecosystems science and a submarine-cave authority at UM's Rosenstiel School of Marine and Atmospheric Science, credits the work of Albury and Brian Kakuk -- an expert caver and guide who has explored more of the islands' holes than anyone else -- for drawing wider research interest.

Kakuk was working as a diver for the U.S. Navy on Andros Island when he took his first plunge, right about the time researchers first discovered the remains of ancient Lucayans in one of the dozens of inland blue holes peppering the island chains. As he began discovering fossils in places no diver had ever visited, he became more and more fascinated by formations that many locals used for waste dumps or considered haunted.

"I kind of took on a role of showing people why it's an amazing place and not just a dark scary hole," Kakuk said.

In 2004, while guiding a diver in the Sawmill Sink on Abaco, he stumbled on something that would put the Bahamas on the map of paleontologists -- spotting a shell in the sediment that looked like no sea turtle he knew. It turned out to be an unknown species of land tortoise, last trundling the Bahamas 2,000 years before humans arrived.

Soon, he and Albury, who is also a cave diver, were finding more and more. Albury, who is now pushing to create a blue hole park on Abaco and expand protections for them, turned her guest house into a lab to

permanently preserve the growing collection. Kakuk, who was the expeditions' dive safety officer, has helped researchers identify so many microscopic animals that he has four named after him.

"To me, it comes back to the big picture of how special these places are," Kakuk said. "How many people, especially as a nonscientist, have the opportunity to find new species?"

Broad, a cave-diving authority named an "emerging explorer" by National Geographic Society, thought the holes promising enough that he secured society and National Science Foundation funding for a deeper look -- figuratively and literally. Some dives took researchers down as far as 275 feet.

With the deepest cavern -- Dean's hole on Long Island -- documented at 663 feet, there is a lot left to explore, perhaps 80 percent of the caverns by Kakuk's estimate. And to study, Broad said.

"Underwater caves are certainly the least understood ecosystems on the planet," he said. "We're just scratching the surface."

Blue holes don't go just straight down; they widen into a maze of uncharted holes, tunnels and caverns -- foolhardy diving for anyone without experience, training and the high-tech gear required for long dives at extreme depths.

In one cavern, the researchers encountered a disturbing reminder of the danger -- the remains of a diver, clad in scuba gear from the 1970s. It's been left undisturbed for decades, Kakuk said, at the request of the ill-fated explorer's family.

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