

Across the Arctic, lakes are leaking dangerous greenhouse gases

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Methane gas released from seep holes at the bottom of Esieh Lake ripples the surface. : Washington Post photo by Jonathan Newton
-JONATHAN NEWTON



A rainbow shines over Esieh Lake, with the seep field of methane gas visible in the center. : Washington Post photo by Jonathan Newton
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ABOVE THE ARCTIC CIRCLE, ALASKA - Katey Walter Anthony has studied some 300 lakes across the tundras of the Arctic. But sitting on the mucky shore of her latest discovery, the Arctic expert said she'd never seen a lake like this one.

Set against the austere peaks of the Western Brooks Range, the lake, about 20 football fields in size, looked like it was boiling. Its waters hissed, bubbled and popped as a powerful greenhouse gas escaped from the lake bed. Some bubbles grew as big as grapefruits, visibly lifting the water's surface several inches and carrying up bits of mud from below.

As the permafrost thaws across the fast-warming Arctic, it releases carbon dioxide, the top planet-warming greenhouse gas, from the soil into the air. Sometimes, that thaw spurs the growth of lakes in the soft, sunken ground, and these deep-thawing bodies of water tend to unleash the harder-hitting methane gas.

But not this much of it. This lake, which Walter Anthony dubbed Esieh Lake, looked different. And the volume of gas wafting from it could deliver the climate system another blow if lakes like this turn out to be widespread.

he first time Walter Anthony saw Esieh Lake, she was afraid it might explode - and she is no stranger to the danger, or the theatrics, of methane. In 2010, the University of Alaska at Fairbanks posted a video of the media-savvy ecologist standing on the frozen surface of an Arctic lake, then lighting a methane stream on fire to create a tower of flame as tall as she is. It got nearly half a million views on YouTube.

So now, in the Arctic's August warmth, she had come back to this isolated spot with a small research team, along with her husband and two young sons, to see what secrets Esieh Lake might yield. Was it simply a bizarre anomaly? Or was it a sign that the thawing Arctic had begun to release an ancient source of methane that could worsen climate change?

One thing she was sure of: If the warming Arctic releases more planet-warming methane, that could lead to . . . more warming. Scientists call this a feedback loop.

"These lakes speed up permafrost thaw," Walter Anthony said. "It's an acceleration."

There was only so much the team would learn from the instruments they had hauled here. To get a firsthand look, they would have to get in.

They'd brought their wet suits.

Walter Anthony, who grew up close to Lake Tahoe, was captivated by Arctic lakes at 19, when she spent a summer at Siberia's picturesque Lake Baikal.

"I love the solitude of remote lakes and the mystery of what lies beneath the water surface."

Two decades and several academic degrees later, she was asked by a Native Alaskan group, the NANA Regional Corporation, to search for methane seeps in northwest Alaska, since the gas, despite its climate downsides, could provide a fuel source for remote communities.

How do you find a lake in Alaska that leaks methane? Well, there's one telltale sign: They don't fully freeze over.

In April 2017, Walter Anthony put out word among residents of Kotzebue, Alaska, that she was looking for weird lakes. An email that month from a pilot led her to the Noatak region, not far above the Arctic Circle. Last September, she made her first visit to the lake - set against sloping hills covered with rust-colored mosses and blueberry bushes. She brought her family and a graduate student to the spot, so remote it required several days of camping and was completely off the grid.

At first, the sheer volume of gases at Esieh Lake was slightly terrifying, but as Walter Anthony grew accustomed to the lake's constant spluttering, her fear gave way to wonder.

Her sounding devices picked up huge holes in the bottom of the lake. Pockmarks, she called them, "unlike anything I've ever seen in any Arctic lake."

Most of Esieh is quite shallow, averaging only a little over three feet deep. But where the gas bubbles cluster, the floor drops suddenly, a plunge marked by the vanishing of all visible plant life.

Measurements showed that the lake dips to about 50 feet deep in one area and nearly 15 feet in another. When they first studied them, Walter Anthony and her graduate student Janelle Sharp named these two seep clusters W1 and W2, short for "Wow 1" and "Wow 2."

The next discovery came from the lab.

When the scientists examined samples of the gases, they found the chemical signature of a "geologic" origin. In other words, the methane venting from the lake seemed to be emerging not from the direct thawing of frozen Arctic soil, or permafrost, but rather from a reservoir of far older fossil fuels.

If that were happening all over the Arctic, Walter Anthony figured - if fossil fuels that had been buried for millennia were now being exposed to the atmosphere - the planet could be in even deeper peril.

For the second trip, Walter Anthony had brought a larger team of researchers, more equipment and her family - her husband, Peter Anthony, and sons, Jorgen, 6, and Anders, 3.

The team brought instruments for sampling gases, four inflatable boats, large crates of food, eight tents, a satellite phone for emergencies, and two shotguns. As with much of the Alaskan wilderness, the lake is frequented by grizzly bears, and the bear scat around the camp kept everyone keenly aware of their surroundings.

A week before the trip, Walter Anthony had published a major study delivering worrisome news about Arctic lakes in general. Her husband - also a scientist at the University of Alaska at Fairbanks - was a co-author.

The research tackled the central question now animating scientists who study permafrost soils, which can reach depths of nearly 5,000 feet and were laid down over tens of thousands of years or more as generations of plants died and sank beneath the surface. Because of the cold, those carbon-rich remains never fully decomposed, and the soil preserves them in an icy purgatory. Now, though, as the Arctic warms, decomposition is starting up - and it gives off greenhouse gases.

Scientists know the permafrost contains an enormous amount of carbon - enough to catastrophically warm the planet if it were all released into the atmosphere. But they don't know how fast it can come out and whether changes will be gradual or rapid.

That's where Walter Anthony's work came in.

The authors examined the prevalence of thermokarst lakes, which form when the wedges of ice within permafrost melt and create voids that then fill with water. And they found that the continuing growth of these lakes - many of which have already formed in the tundra - could more than double the greenhouse gas emissions coming from the Arctic's soils by 2100. That's despite the fact that the lakes would cover less than 6 percent of the total Arctic land surface.

Scientists have been puzzling over a dramatic spike in atmospheric methane levels, which since 2006 have averaged 25 million tons more of the gas per year. Walter Anthony's study found that Arctic lakes could more than double this increase as well.

Overall, if Walter Anthony's findings are correct, the total impact from thawing permafrost could be similar to adding a couple of large fossil-fuel-emitting economies - say, two more Germanys - to the planet. And that does not take into account the possibility of more lakes like Esieh, which appears to be a different phenomenon from thermokarst lakes, emitting gases faster

The landscape around Esieh Lake itself bears the mark of rapid permafrost thaw.

Along the shore, a large section of the hillside had collapsed, a change that, according to two members of the team, had occurred just since May, when they were last here.

This "thaw slump" was a textbook example of fast-moving permafrost thaw. It had left behind an exposed wall of muddy ice and small islands of peat and mosses.

If it weren't for the bubbles, the large patches of silty water they create and the slightly unsettling fact that you could light the emerging gases on fire (at one point, Walter Anthony did just that), Esieh Lake might be an idyllic scene. But these features, combined with the fact that it appears to be frequented by grizzly bears, render it more alien than bucolic.

But Walter Anthony and her research technician Philip Hanke, 25, were determined to explore it from within. On the second day of the trip, they donned wet suits and snorkels and plunged into the cold water, which was below 60 degrees.

They wanted to see the methane seeps up close and learn what they could by swimming among the bubbles.

Hanke went first, venturing into the more vigorous bubble site, Wow 2. There was very little visibility. But, groping in the darkness, Hanke could feel the shape of things.

"It's kind of freaky," he reported after he surfaced. "Right where the hole goes in, it slopes, and it's flattened out, and it coned back down, and that was where some really loose sediment was, and I could stick my hands into it."

"So there's different ledges, you're saying?" Walter Anthony asked.

"Yeah, it was a ledge."

The second, much deeper site was less murky, more peaceful. Walter Anthony was still in awe when she came up for air.

"You're just looking down into this stream of bubbles coming up right into your face, and they're so soft they go all around you," she said. "And the sunlight's on them. It's like out of this world but under this world."

Another scientist, Frederic Thalasso, had traveled from Mexico City and spent days taking gas measurements around the lake. His initial results: Emissions from Esieh were very high - and clearly had something to do with fossil fuels.

The lakes where he had witnessed similar bubbling activity were in the tropics and polluted - ideal conditions for the production of methane, said Thalasso, a scientist with the Center for Research and Advanced Studies at the National Polytechnic Institute in Mexico.

But those lakes have gas flows that are "probably 100 times lower than in this lake," he said.

His instruments also detected ethane, butane and propane - classic signatures of a fossil origin.

Later, after processing his data, he produced an initial estimate that the lake was producing two tons of methane gas every day - the equivalent of the methane gas emissions from about 6,000 dairy cows (one of the globe's biggest methane sources). That's not enough to be a big climate problem on its own, but if there are many more lakes like this one - well, that's another story. - - -

After four nights of camping, the team packed up to make the two-hour boat trip to Kotzebue, Alaska, the first leg on the journey home. Walter Anthony wouldn't have all the new data processed for a while, but she did have a pretty good hypothesis about what is happening at Esieh Lake.

Permafrost contains a lot of carbon - but in some locations, permafrost soil, and its characteristic wedges of embedded ice, also sits atop ancient reserves of fossil fuels, including methane gas. So as the Arctic warms - which it is doing twice as fast as the rest of the Earth - these gases could be liberated into the atmosphere.

The holes in the bottom of Esieh Lake could therefore be an underwater cousin of odd craters that have appeared in the Siberian tundra in recent years, suspected to have been caused by underground gas explosions.

If this is right, then Esieh Lake becomes a kind of hybrid - and a worrying one.

It's not a pure thermokarst lake, though some thermokarst appears to be forming around the lake's expanding edges, tipping shoreline trees as the ice in the permafrost melts and the ground destabilizes. But the thawing of permafrost at the lake bed might also have unleashed older fossil gases from a reserve that had been sealed - creating another kind of worrisome lake.

"This is an additional source," Walter Anthony said.

Carolyn Ruppel, who leads the Gas Hydrates Project at the U.S. Geological Survey, said Walter Anthony's theory makes sense. Permafrost thawing could indeed release ancient fossil fuels in areas where they intersect.

But it would take more study to prove that this phenomenon is leading to widespread emissions across the Arctic, she cautioned.

Nobody knows how long ago the seeps started bubbling or what the trigger was.

From a scientific perspective, the fact that these lakes are emitting methane rather than carbon dioxide does have an admittedly limited upside.

Methane hits the atmosphere hard and fast and then mostly dissipates after a decade or two - far different from carbon dioxide, which is less potent but lingers for centuries or even millennia. So while methane impedes climate progress and amps up the planet's immediate temperature, it does not leave the same long-term legacy.

Meanwhile, some scientists say they're not sure yet how bad Arctic lakes will be for the climate or whether they will indeed cause emissions from permafrost to double.

"It's not the final number," said Vladimir Romanovsky, one of Walter Anthony's colleagues at the University of Alaska at Fairbanks and a noted permafrost expert.

At this point, it would be premature to call Esieh Lake a sign of climate doom. It is a strange and dramatic site, but its message remains partly veiled.

The coming years will probably reveal what's behind Esieh and whether it has many cousins across the top of the world.

By then, we may also see whether the Arctic's great thaw will have thwarted attempts to stop global warming.

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