http://www.latimes.com/news/nationworld/nation/la-na-global-warming-methane22-2009feb22,0,1984453.story
From the Los Angeles Times

Bubbles of warming, beneath the ice

As permafrost thaws in the Arctic, huge pockets of methane -- a potent greenhouse gas -- could be released into the atmosphere. Experts are only beginning to understand how disastrous that could be.

By Margot Roosevelt

February 22, 2009

Reporting from Bering Land Bridge National Preserve, Alaska -- Four miles south of the Arctic Circle, the morning sky is streaked with apricot. Frozen rivers split the tundra of the Seward Peninsula, coiling into vast lakes. And on a silent, wind-whipped pond, a lone figure, sweating and panting, shovels snow off the ice.

The young woman with curly reddish hair stops, scribbles data, snaps a photo, grabs a heavy metal pick and stabs at white orbs in the thick black ice.

"Every time I see bubbles, I have the same feeling," says Katey Walter, a University of Alaska researcher. "They are amazing and beautiful."

Beautiful, yes. But ominous. When her pick breaks through the surface, the orbs burst with a low gurgle, spewing methane, a potent greenhouse gas that could accelerate the pace of climate change across the globe.

International experts are alarmed. "Methane release due to thawing permafrost in the Arctic is a global warming wild card," warned a report by the United Nations Environment Program last year. Large amounts entering the atmosphere, it concluded, could lead to "abrupt changes in the climate that would likely be irreversible."

Methane (CH_4) has at least 20 times the heat-trapping effect of an equivalent amount of carbon dioxide (CO_2). As warmer air thaws Arctic soils, as much as 55 billion tons of methane could be released from beneath Siberian lakes alone, according to Walter's research. That would amount to 10 times the amount currently in the atmosphere.

At 32, Walter, an aquatic ecologist, is a rising star among the thousands of scientists who are struggling to map, measure and predict climate change. Parts of her doctoral dissertation on Siberian lakes were published in three prestigious journals in 2007: Science, Nature and Philosophical Transactions of the Royal Society.

According to one of her studies, methane emissions from Arctic lakes were a major contributor to a period of global warming more than 11,000 years ago.

"It happened on a large scale in the past, and it could happen on a large scale in the future," says Walter, who refers to potential methane emissions as "a time bomb."

Methane levels in the atmosphere have tripled since preindustrial times. Human activities, including rice cultivation, cattle raising and coal mining, account for about 70% of releases, according to recent studies. Natural sources, like tropical wetlands and termites, make up the rest. But those estimates had not incorporated the bubbles Walter was probing on an autumn morning on the Seward Peninsula.

That gurgling gas could change the entire model for predicting global warming. And lakes are not the only methane source: Newly discovered seeps -- places where methane leaks to the surface -- from the shallow waters of Siberia's vast continental shelf are also likely to upset previous assumptions.

Walter's work "has gotten a lot of attention," said John E. Walsh, chief scientist of the International Arctic Research Center in Fairbanks. "She found direct evidence of methane releases in high-latitude lakes. That

was not fully realized before."

In a field where the science often seems opaque, Walter's research has a flashy side. She enjoys igniting methane seeps with a cigarette lighter, leaping away as the gas flares as high as 20 feet.

"It's fun," she says. "And it is informative."

Videos of the stunts have swept through the Internet, rare visual evidence of possible danger ahead. At a recent Senate hearing, Al Gore played a clip of her lighting a methane seep. The BBC, the Discovery Channel and the History Channel have featured her in documentaries.

But the complex science of Arctic methane is only beginning to be understood. In the desolate wilderness of the Bering Land Bridge National Preserve, a sense of urgency is palpable among Walter and three fellow researchers, hunkered down in neon-orange tents.

An occasional helicopter ferries supplies from Nome, the closest town, soaring over scattered herds of caribou. A red fox scampers through the brush. Across a snowfield, bear tracks recede into the distance, a reminder that field science isn't for sissies.

"Can you shoot a gun?" Walter asks a visitor, as she heads out to one of 20 lakes she is surveying. When the answer is noncommittal, she hands over bear spray and instructs: "Don't use it until the bear is right up close, facing you."

Nowhere is the evidence of a heating planet more dramatic than in the polar regions. Over the last 50 years, the Arctic has warmed twice as fast as the rest of the globe. Last summer, for the first time in recorded history, the North Pole could be circumnavigated. Ice sheets on Greenland and West Antarctica are melting rapidly. Polar bears and emperor penguins are threatened with extinction.

Even as glaciers and sea ice have captured the most headlines, growing concern is now focused on the transformation of permafrost, soils that are frozen year-round.

Today, 20% of Earth's land surface is locked up in a deep freeze. But scientists predict that air temperature in the Arctic is likely to rise as much as 6 degrees Celsius, or 10.8 degrees Fahrenheit, by the end of the century. That is expected to boost the emission of carbon compounds from soils.

The upper 3 meters -- about 10 feet -- of permafrost stores 1.9 trillion tons of carbon, more than double the amount in the atmosphere today, according to a recent study in the journal Bioscience.

"We are seeing thawing down to 5 meters," says geophysicist Vladimir Romanovsky of the University of Alaska. "A third to a half of permafrost is already within a degree to a degree and a half [Celsius] of thawing."

If only 1% of permafrost carbon were to be released each year, that could double the globe's annual carbon emissions, Romanovsky notes. "We are at a tipping point for positive feedback," he warns, referring to a process in which warming spurs emissions, which in turn generate more heat, in an uncontrollable cycle.

Walter's work is crucial, according to Romanovsky and others, because global warming hinges partly on the ratio of how much carbon is released as CO_2 versus how much as methane, a molecule that contains both carbon and hydrogen. Methane, although a far more potent greenhouse gas than carbon dioxide, breaks down more quickly. But when it does, it oxidizes into a carbon dioxide molecule, which can last more than a century in the atmosphere.

Out on the lake, Walter explains: When organic matter (dead plants and animals) rots in the ground, it gives off carbon dioxide. Much of the organic material of thawed permafrost is expected to release carbon dioxide.

But as ice inside permafrost melts, small sinkholes open in the ground and fill with water, joining together to form millions of ponds and lakes. Organic matter slips from eroding shorelines to lake bottoms, where microbes feed on it. Because lake bottoms are oxygen-free, the microbes generate methane in addition to carbon dioxide -- as in the burping La Brea tar pits.

"These lakes are getting bigger -- in some places by a meter a year," Walter says, scooping out slush from the hole she has punched through 6 inches of ice. Into the seep, she inserts a plastic umbrella-like

contraption fitted with a bottle to collect gas and a suspended brick to hold it straight.

Before Walter perfected the methane trap, when she was a graduate student in Siberia, she would swim in near-freezing water, dodging leeches and muskrats. Once she caught pneumonia. Another time, her hair caught on fire as she ignited a methane seep.

On the Seward Peninsula trip, she hikes up to 8 miles a day from lake to lake through snowdrifts. Her hip is black and blue from a fall through the ice. "Methane is hard work," she says with a smile.

At each seep, Walter places a small red flag so her colleagues can find the bubbles. Lawrence Plug, a geophysicist from Dalhousie University in Halifax, Canada; Guido Grosse, a German geologist; and Benjamin M. Jones, a U.S. Geological Survey researcher, help shovel off the ice in straight-line paths, take notes on the size of each bubble group, record the location with global positioning system devices, and measure the depth of the lakes.

In the evening, in a cramped cook tent, jars of peanut butter and Nutella sit amid satellite data maps and a textbook on "Applied Linear Statistical Models." Frosted hats and mittens drip from a clothesline. Jones cooks up a batch of hamburger as Walter labels methane bottles with a marker and enters data into her laptop.

Over the next two years, the researchers, funded by the National Science Foundation and NASA, will move between Siberia and Alaska. They will drill permafrost cores, map seeps and analyze data to produce a model of how methane from Arctic lakes might affect Earth's future climate.

"By figuring out how quickly permafrost thawed in the past, we can test our models to predict how fast it could thaw in the next 100 years," says Plug, who will make the complex calculations. "If the temperature warms a couple of degrees Celsius, the lakes could expand at two or three times their current rate."

Elsewhere, scientists cast a wary eye toward clouds of methane bubbles roiling the waters of the Siberian continental shelf. Those emissions, possibly from subsurface permafrost, are even harder to measure than lake emissions.

Meanwhile, researchers are debating the possibility of eventual seeps from methane hydrates -- icy formations beneath the continental shelves and the ocean bottom, and far below land-based permafrost.

Walsh, at the International Arctic Research Center, emphasizes the "huge range of uncertainty" as to how much climate change methane emissions could trigger. "The potential is there for large releases. But there is also a risk of alarmism."

To many Alaskans, it is hardly news that permafrost is thawing: Across the state, houses have been collapsing and trees tipping over. Researchers estimate that repairing affected schools, roads and bridges will cost up to $6 billion over the next two decades.

But the global implications have yet to sink in.

Out on the wild frontier of climate research, far from the legislatures and the diplomatic gatherings where climate policy is debated, Katey Walter and her colleagues focus on what they call "ground truthing."

And beyond that laborious data-gathering, Walter has a mission: to spread the word about what is happening. At the beginning of her field trip, she stops in Nome and leads a group of fifth-graders, many from Alaska Native tribes, out to poke holes in the ice of a nearby lake and light methane flares.

She talks to them about people who live in faraway cities, driving automobiles and working in industries that emit carbon dioxide. And how that causes warming that is felt in the Arctic. And why, even though there are so few people in Alaska, the ice around them is melting.

"That's what we're studying," she explains. "It's all related."

margot.roosevelt@latimes.com

LATIMES.COM /WARMING

See video of Walter's research team as they drill through permafrost and ignite a

methane bubble.
