BRITISH ANTARCTIC SURVEY

ICY INVESTIGATIONS The British mission sets up to explore Lake Ellsworth, which lies 3 km below Antarctica's ice.

SCIENTISTS SCOPE OUT FRIGID LAKES

Russian, American, and British teams prepare to explore lakes deep under ANTARCTICA'S GLACIERS

SARAH EVERTS, C&EN BERLIN

RUSSIAN SCIENTISTS made international headlines this month when they bored 3.8 km—2.5 miles—into Antarctic ice to contact an ancient lake that had been undisturbed for millions of years. They reached their target just as extreme weather conditions from the impending Antarctic winter forced them to leave the icy continent.

Feted at home and internationally for an engineering feat that was 20 years in the making, the Russian scientists will have to wait until Antarctica's next summer—a whole 10 months away—before they can analyze their bounty, ancient water from Lake Vostok that gushed into their borehole.

Valery Lukin, head of the Russian mission, tells C&EN that waiting nearly a year before his team can study the Lake Vostok sample will require patience similar to that of Mars mission scientists who had to wait years after a launch to get data. The analogy is apt because anything living in the harsh conditions of Lake Vostok, possibly exotic microbes with a 15 million-year-old pedigree, may provide clues about life on other planets.

By the time Lukin and his colleagues return to Antarctica to examine their lake sample, British and American scientists will have launched their own major explorations of two other subterranean waterways on the continent. If these new explorations go according to plan, scientists on the U.S. and U.K. projects will acquire, after a few days of concentrated activity and a decade of planning, much more data about subglacial lakes than the current Russian effort is likely to—albeit on smaller, less isolated lakes. The explorations could yield information about paleoclimates; ancient, exotic microorganisms; and biogeochemical fluxes from Antarctic lakes to exterior oceans.

Of the hundreds of waterways buried below Antarctic glaciers, the Americans chose to study Lake Whillans, which is "more like a river of ice than a lake," says John C. Priscu, a Montana State University biogeochemist who is involved with the U.S. mission, which is being funded by the National Science Foundation.

BECAUSE MANY of Antarctica's subglacial water systems drain to the Southern Ocean via Lake Whillans, the water sampled there will likely contain a diverse collection of microbes from different subglacial lakes on the continent, Priscu says. The plan is to bore at least five holes to Whillans at multiple points on the waterway's trajectory to the Southern Ocean starting next November or December, he says.

In particular, the American scientists will check to see how microorganisms in Whillans' waters are metabolizing iron and how this metabolism contributes to global geochemistry cycles. "We think [the microbes] might be mining insoluble ferric iron [from the bedrock] for their metabolism and then releasing soluble iron that then flows to the ocean," he says. If iron goes from the subglacier lakes into the Southern Ocean, then more algae can grow there, which would create a CO_2 sink, Priscu adds.

This kind of subglacial microbial metabolism could be affecting the geochemistry of the surrounding ocean, and thus weather and climate, in ways that have not yet been included in climate models, says Brent C. Christner, a microbiologist at Louisiana State University involved in the U.S. mission. "This work is probably not going to

UNDERGROUND TREASURE

Three missions to explore Antarctica's underground lakes are in the works. Here's how the Russian, British, and American projects stack up.

	LAKE VOSTOK	LAKE ELLSWORTH	LAKE WHILLANS
Country	Russia	U.K.	U.S.
Depth beneath ice to dig (meters)	3,769	3,000	800
Time under glacier (million years)	15–25	0.1–1.0	0.1–1.0
Volume of lake (km^3)	5,400	0.5–1.4	0.5
Depth of lake (meters)	200–800	150	10–15
Area of lake (km^2)	14,000	29	60
Funding (millions of U.S. dollars)	na	10.5	10.0

NOTE: These are current estimates. More accurate figures will be available after explorations next year. **na** = not available. **SOURCES**: British Antarctic Survey, National Science Foundation

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make things simpler" for climate modelers, he adds.

The British mission, also set to start next November or December, is focused on Lake Ellsworth, a fjordlike lake that has been isolated from the outside world for about half a million years, says the British Antarctic Survey's David Pearce, who is part of the U.K. project. Both Lakes Ellsworth and Vostok are isolated water systems, but Vostok is likely millions of years older and has a volume that's about 10,000 times greater than Ellsworth, Pearce explains.

"Vostok is very ancient and big, so there could be some really interesting biodiversity there," Pearce says. "If Vostok is full of life, then Ellsworth probably is too. If either lake is sterile then this would also be incredibly interesting because there's currently no known sterile place on Earth," he adds.

If any of the teams find microbial life in their samples, they will sequence the microbes' DNA and also try to figure out what the microbes are subsisting on, Christner says. In such bitterly cold and high-pressure environments microbes could survive off organic dust trapped in the glacier, which melts into the lake water below. Or microbes might consume minerals that are pulverized (and thus liberated) when Antarctic ice grinds over bedrock. Or the lakes' floors may be dotted with hydrothermal vents that spew hydrosulfide or iron oxide snacks to microbes nearby.

BOTH THE U.K. AND U.S. teams will bore pathways through glaciers to Lakes Ellsworth and Whillans using hot water that's been sterilized with ultraviolet light and filters. It's a faster route than the Russians' mechanical boring route, and it doesn't require potential contaminants such as kerosene. But so far hot-water boring has been tested only through about 2 km of ice, about two-thirds of the distance the U.K. team needs to traverse next December to reach Ellsworth but farther than the American team will have to bore down to Lake Whillans, Pearce says.

A disadvantage of using hot water to reach the underground lakes is that "as soon as you create the hole it starts to freeze again," Pearce says. His team will have a mere 24 hours to bore into the lake, sample all 150 meters of the Ellsworth water column, collect samples at the lake's bottom, and complete a host of other experiments before the hole refreezes.

Still, if successful, these experiments could yield much more data than will the sample of Vostok's surface lake water that burst up into the borehole, which will freeze over the winter and be collected by the Russian mission next November or December.

The Vostok experiment "is like going out to Lake Superior in midsummer, taking a bucket of water, and going back to the lab to analyze it," Priscu says. "They don't have any sediment or water column. They just a have a sip of water to study."

However, Russia's Lukin says that his team will still be able to search for microbial life, do chemical analyses, and study the structure of the ice crystals in their frozen lake water sample. Lukin adds that the Russian team plans to send equipment deeper into the lake during the following summer season (2013–14) using a new Russian-designed system under development. The new system will deploy equipment into the lake that has been protected from any boring chemicals as it traveled downward. Lukin takes issue with the American and British hot-water-boring technology, which he says could harm microbes in the lakes by heating them up.

Pearce estimates that it could take many years to prepare for a thorough study of Lake Vostok. It took more than a decade to plan Ellsworth, he says. "Vostok has more ice to dig through, it's much deeper and has much more water."

Priscu say that he thinks a research trip deep to Vostok's bottom should be part of an international effort. Lukin says he's open to discussing a cooperative mission if all the costs of exploration are shared. "That's the spirit of Antarctic research," Priscu says. "We could all go to the deepest part, get some sediment, and split the costs." ■

& VIDEO ONLINE Learn what British scientists hope to find at the bottom of Lake Ellsworth at cenm.ag/antarctic.