Scientists studying ice cores from a long-isolated and mostly frozen Antarctic lake have discovered an unexpectedly diverse colony of microbes eking out a living in the dark, salty and super-chilled waters that migrate through the ice. The find not only broadens our understanding of habitable conditions for life on Earth, researchers suggest, but may provide clues about the potential for life in icy environments in the rest of the solar system.

The microbe-containing cores were drilled during expeditions in 2005 and 2010 to Lake Vida, the largest of many ice-sealed lakes in Antarctica’s coastal McMurdo Dry Valleys near the Ross Sea. Earlier studies of the lake had indicated a layer of ice up to 20 meters thick that was thought to cover a briny pool of liquid water isolated from the outside world for about 3,000 years. But rather than “an underlying water body like a lake,” what researchers found when they looked at the core was that, below a depth of about 16 meters, “the liquid brine in the system is entrained in a network of channels in the ice,” says Alison Murray, a geomicrobiologist at the Desert Research Institute in Reno, Nev., and lead author on a new study reporting the discovery in Proceedings of the National Academy of Sciences.

Using specially designed pumps and mobile laboratory tents set up on the lake’s surface to avoid contaminating the long-buried, pristine environment, Murray and her team sampled the brine that flowed into the boreholes they drilled. Analyses showed that the slightly acidic and oxygen-free water had high concentrations of dissolved salts — six times that of seawater — and metals including iron. Antarctic lakes are often very salty, but Lake Vida has “a really rich geochemistry” that also includes high levels of inorganic and organic carbon and gases like hydrogen and nitrous oxide, which “sets it apart from the ocean or even the bottom waters of some of the other [Antarctic] lakes,” Murray says. Additionally, the temperature of the brine, kept liquid by virtue of its high salinity, was minus 13 degrees Celsius, colder than virtually any other liquid water body on Earth.

Given the uniquely harsh conditions, Murray says she and her colleagues were “astounded at the high levels of [microbial] cells that were in the brine.” For the most part, the microbes appear to be relatives of bacteria that have been found elsewhere, including some in other Antarctic waters. Surprisingly, archaea — microorganisms often adapted to extreme environments — have not yet been identified in the system. But what’s really novel, Murray says, is the great variety of phyla they found. “It represents a metabolically diverse group of organisms” that are likely “using different types of energy sources and resources in the system.”

The sources of energy remain unclear, however, as the lake receives no sunlight or external inputs of nutrients. Murray and her colleagues suspect that reactions between the brine and thin layers of iron-rich sediment — deposited long ago before the lake was fully frozen and now intermingled with the ice — may be part of the story. The researchers suggest that these reactions could be responsible for the high levels of nutrients and gases, particularly hydrogen.
Scientists drilled into Antarctica’s frozen Lake Vida and found a surprisingly diverse population of bacteria living in a network of brine channels buried in the ice. The channels, which are intersected by thin layers of sediment that may provide the energy needed by the bacteria to survive in the harsh environment, extend from about 16 meters below the lake’s surface to at least 27 meters, the maximum depth to which the researchers have cored.

in the brine, which some bacteria can exploit to power their metabolism.

Murray’s team also discovered that, despite abundant nutrient availability, the microbes’ metabolism supported little more than the bare minimum needed to survive: producing and repairing critical proteins, DNA and RNA, for example.

“It’s an exciting discovery,” says Lisa Pratt, a biogeochemist at Indiana University who was not involved in the study. The “bedrock geology, in the form of sediment,” seems to be “playing a very unexpected, important role in the energy sources that are available in this mixture of material.” But, Pratt points out, many other questions about Lake Vida’s ecosystem remain open.

In particular, what is it about the lake that is restricting the bacteria to such low levels of activity? It’s possible, Pratt says, that minus 13 degrees Celsius is “close to the limit for life on Earth.”

Murray agrees that there is a lot of work left to be done to understand the new ecosystem, including conducting a more detailed genomic survey of the life in Lake Vida and confirming whether the hypothesized brine-sediment interactions are indeed occurring. But already, she says, the find has “expanded our view of what is habitable” on Earth, which “may help us when we’re looking at icy worlds and thinking about whether there is liquid trapped in the ice.”

“This is the first study I know of in which you have this … open brine network cutting across stratified layers of sediment and ice,” Pratt says. “And when I think of a place like Mars, where you have a lot of wind-blown dust that is getting onto layers of ice and being buried,” Lake Vida could make for “an interesting analog.”

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