Oxygen oasis in Antarctic lake reflects Earth in the distant past

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Lake Fryxell, Antarctica is permanently covered in ice, and the waters at the bottom are oxygen-free but still receive some sunlight. Scientists have discovered a thin layer of oxygen created by photosynthetic bacteria at the bottom of the lake. This could be a model for conditions on Earth 2.4 billion years ago, before oxygen became common in the atmosphere. Credit: Tyler Mackey, UC Davis

At the bottom of a frigid Antarctic lake, a thin layer of green slime is generating a little oasis of oxygen, a team including UC Davis researchers has found. It's the first modern replica discovered of conditions on Earth two and a half billion years ago, before oxygen became common in the atmosphere. The discovery is reported in a paper in the journal *Geology*.

The switch from a planet with very little available oxygen to one with an atmosphere much like today's was one of the major events in Earth's history, and it was all because some bacteria evolved the ability to photosynthesize. By about 2.4 billion years ago, geochemical records show that oxygen was present all the way to the upper atmosphere, as ozone.

What is not clear is what happened in between, or how long the transition - called the Great Oxidation Event - lasted, said Dawn Sumner, professor and chair of earth and planetary sciences at UC Davis and an author on the paper. Scientists have speculated that here may have been "oxygen oases," local areas where was abundant before it became widespread around the planet.

The new discovery in Lake Fryxell in the McMurdo Dry Valleys could be a modern example of such an ancient oxygen oasis, and help geochemists figure out what to look for in ancient rocks, Sumner said.

Sumner and collaborators including Ian Hawes of the University of Canterbury, New Zealand have been studying life in these ice-covered lakes for several years. The microbes that survive in these remote and harsh environments are likely similar to the first forms of life to appear on Earth, and perhaps on other planets.

The discovery occurred "a little by accident," Sumner said. Hawes and Tyler Mackey, a UC Davis graduate student working with Sumner, were helping out another research team by diving in Lake Fryxell. The lakes of the Dry Valleys typically contain oxygen in their upper layers, but are usually anoxic further down, Sumner said. Lake Fryxell is unusual because it becomes anoxic at a depth where light can still penetrate.

During their dives below the oxygen zone, Hawes and Mackey noticed some bright green bacteria that looked like they could be photosynthesizing. They took measurements and found a thin layer of oxygen, just one or two millimeters thick, being generated by the bacteria.

Something similar could have been happening billions of years ago, Sumner said.

"The thought is, that the lakes and rivers were anoxic, but there was light available, and little bits of oxygen could accumulate in the mats," she said.

The researchers now want to know more about the chemical reactions between the "oxygen oasis" and the anoxic water immediately above it and sediments below. Is the oxygen absorbed? What reactions occur with minerals in the water?

Understanding how this oxygen oasis reacts with the environment around it could help identify chemical signatures preserved in rocks. Researchers could then go looking for similar signatures in rocks from ancient lake beds to find "whiffs of oxygen" prior to the Great Oxidation Event.

More information: *Geology*, geology.gsapubs.org/content/ea … 6966.1.full.pdf+html

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