Our Ancestors Survived 'Snowball Earth'

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It has been 2.3 billion years since Earth's atmosphere became infused with enough oxygen to support life as we know it. About the same time, the planet became encased in ice that some scientists speculate was more than a half-mile deep. That raises questions about whether complex life could have existed before "Snowball Earth" and survived, or if it first evolved when the snowball began to melt.

New research shows organisms called eukaryotes – organisms of one or more complex cells that engage in sexual reproduction and are ancestors of the animal and plant species present today – existed 50 million to 100 million years before that ice age and somehow did survive. The work also shows that the cyanobacteria, or blue-green bacteria, that put the oxygen in the atmosphere in the first place, apparently were pumping out oxygen for millions of years before that, and also survived Earth's glaciation.

The findings call into question the direst models of just how deep the deep freeze was, said University of Washington astrobiologist Roger Buick, a professor of Earth and space sciences. While the ice likely was widespread, it probably was not consistently as thick as a half-mile, he said.

"That kind of ice coverage chokes off photosynthesis, so there's no food for anything, particularly eukaryotes. They just couldn't survive," he said. "But this research shows they did survive."

Buick and colleagues studied droplets of oil encased in rock crystals dating from 2.4 billion years ago, recovered from the Elliot Lake area near Sault Ste. Marie, Ontario, Canada. The oil, essentially chemicals left from the breakdown of organic matter, contained biomarkers, or molecular fossils, that can be structurally identified as having come from specific types of life.

"It's the same thing as looking at dinosaur fossils, except these fossils are at the molecular scale. You are looking at the molecular skeletons of carbon molecules, such as cholesterol, held within oil droplets," he said.

This is not the first time biomarkers indicating that eukaryotes and cyanobacteria were alive before "Snowball Earth" have been found in ancient rocks. A paper reaching the same conclusion was hailed as one of the top science breakthroughs of 1999. Buick did some of the research for that paper and was a co-author. But almost from its publication, detractors have said what was seen were not really ancient biomarkers but rather some kind of contamination that got into the samples being studied, possibly from oil flowing through shale rocks at a much later time or modern fossil fuel pollution.

"The contamination idea has always been nattered about in corridors or talked about in meetings, but never put down in print," Buick said. "What this new paper does is confirm these as being very, very old biomarkers."

The lead author of the paper, published in the June edition of Geology, is Adriana Dutkiewicz of the University of Sydney in Australia, for whom Buick served as a postdoctoral mentor. Other authors are Herbert Volk and Simon George of the Commonwealth Scientific and Industrial Research Organization in Australia and John Ridley of Colorado State University.

The researchers examined rock samples obtained from an outcrop near

Elliot Lake, which then were fragmented into pieces less than one-tenth of an inch in diameter. The particles were cleaned thoroughly and checked for contamination throughout the process. The crystal fragments contained numerous minuscule pockets of fluid mostly consisting of water but also containing small amounts of oil, usually in a thin film around a bubble of water vapor. The oil resulted from decaying organic matter, probably of marine origin.

"A drop of oil is a treasure trove. It is highly concentrated molecular fossils," Buick said.

The biomarkers contained in the oil indicate that both eukaryotes and cyanobacteria first appeared before the planetary glaciation, rather than evolving at the same time or later, he said. The samples also suggest that oxygen was being produced long before the atmosphere became oxygenated, probably oxidizing metals such as iron in the Earth's crust and ocean before the atmosphere began filling with oxygen.

Source: University of Washington