

X-treme Microbes: Eating Radioactivity



◀ The newly discovered microbes are found nearly two miles deep in ancient water that seeps through a fracture in 2.7-million-year-old rock containing uranium and an iron-sulfur compound called pyrite, or fool's gold, among other constituents. They live in that harsh environment by taking advantage of a convenient local energy source, radioactivity.

As a uranium atom in the surrounding rock decays, it emits neutrons (flying green balls at upper left) which smash into water molecules (H_2O —depicted as one red oxygen atom and two white hydrogen atoms), splitting off hydrogen atoms in the form of positively charged protons (marked H^+).

The oxygen atoms react with sulfur in the pyrite to form compounds called sulfates. The microbes then use the leftover hydrogen protons to convert the sulfates into related compounds called sulfides, storing some chemical energy in the process. It's not much, but it's enough to sustain life and growth ... barely. Scientists think that it may take the microbes hundreds of years to double their population.

Credit: Nicolle Rager Fuller, National Science Foundation

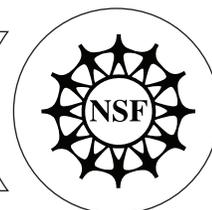
Not so long ago, everyone believed that the primary source of energy for all life was sunlight. Even for carnivores: After all, they eat herbivores that eat vegetation produced by photosynthesis. Ditto for bacteria stuck in the perpetual dark of the human gut, or for lightless ocean-bottom ecosystems that utilize oxygen dissolved

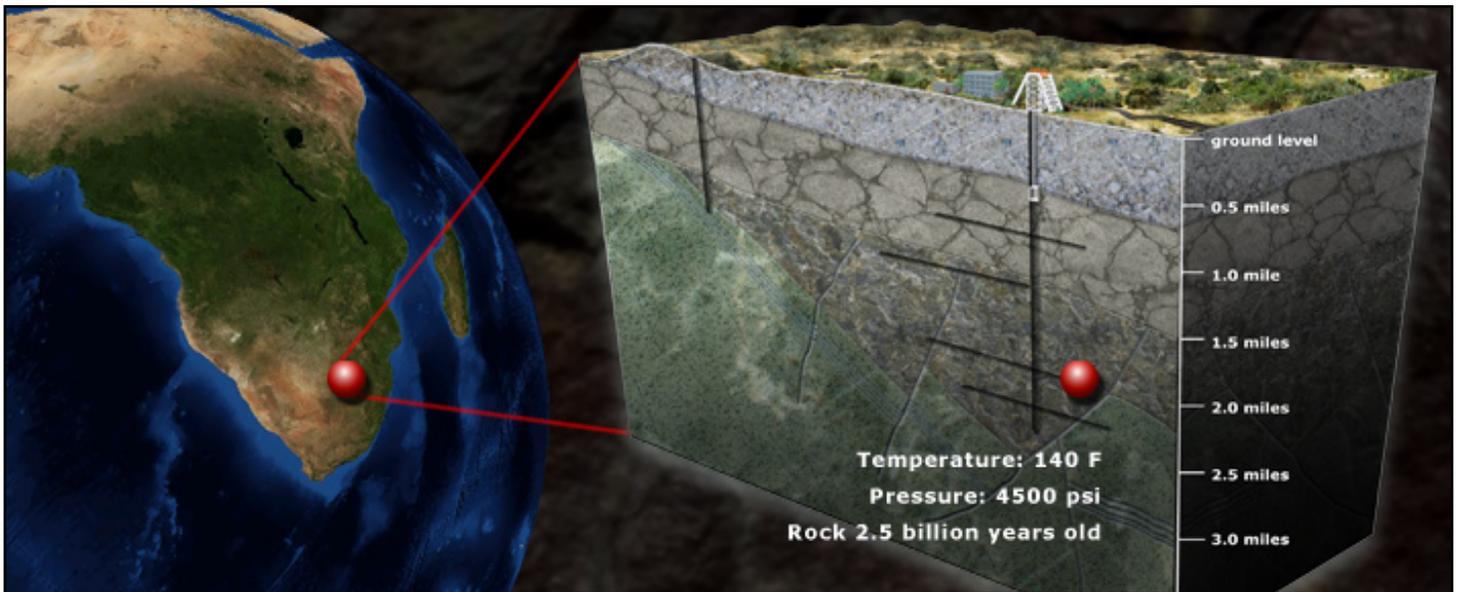
in seawater—oxygen created by sunshine in plants and algae above. Ultimately, it seemed, everything depended on the Sun.

But in the 1960s, scientists began discovering exotic organisms that play by astonishingly different rules. Now, a team searching deep in a South African gold mine has

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Scientists discovered the microbes at the bottom of one of the world's deepest gold mines in South Africa. Miners were drilling exploratory holes in preparation for a new tunnel, and the U.S. researchers took advantage of the situation when the drilling struck a high-pressure water-bearing fracture. They took water samples for 54 days, and found that the samples were dominated by one type of microbe that resembles an extremophile seen elsewhere. Further study may reveal how it is related to others.

found one that redefines the very limits of life: Bacteria that subsist in rock at huge pressure for thousands of years by “eating” by-products of radioactivity, completely isolated from any organic matter or effects of photosynthesis.

Tullis Onstott of Princeton University, Lisa Pratt of Indiana University and colleagues think the microbes may have first trickled down there between three and 25 million years ago, and were forced to survive on the leftovers that result when radioactivity from uranium in the native rock breaks down molecules of water and pyrite (iron sulfide, or fool's gold—see picture caption for full description).

They developed a metabolism based on hydrogen ions and sulfur compounds, rather than the more familiar, carbon-centered organic chemistry used by their topside cousins.

These rock-dwellers may be some of above-ground life's oldest relatives. Pratt and Onstott suspect that

they're probably not much different now than when they were separated from the surface, because they grow very slowly to conserve scarce nutrients.

In fact, “very slowly” is an understatement: Whereas *E. coli*, like those found in the intestines of mammals, divide every few minutes, the subsurface microbes reproduce once a year at most, and possibly only every 300 years ... or more!

So far, researchers haven't been able to grow them in the lab under the microbes' natural conditions. But they are working on genomic sequencing to evaluate how closely related the newly discovered bacteria are to other extremophiles and surface organisms.

In the future, those studies may change the way instruments look for life on Mars. And they may even begin to answer the question: Did life on Earth begin underground?

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