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Cal Poly Professor, Colleagues Discover New Magnetic Bacterium

Findings Could Contribute to Biotech and Nanotech Industries

SAN LUIS OBISPO, Calif. – A Cal Poly physics professor is part of an international team of scientists that discovered, documented and domesticated a magnetic, sulfate-breathing strain of bacteria from the wilds of Death Valley, a feat that will enhance the understanding of how bacteria make minerals and could aid advances in biotechnology and nanotechnology.

Richard Frankel, Cal Poly physics professor emeritus, worked with University of Nevada Las Vegas microbiologist Dennis Bazylinski and other scientists on the project. The group's findings will be published in the Dec. 23 issue of "Science Magazine."

The paper explains how the group identified, isolated and cultivated an unusual strain of magnetotactic bacteria. Magnetotactic bacteria are single-celled organisms found in almost all bodies of water, Frankel explained. Like their name suggests, they swim toward one pole of a bar magnet and away from the other like a swarm of microscopic compass needles. In nature they swim parallel to the Earth's magnetic field.

They are able to do that because they produce nano-sized crystals of the minerals magnetite or greigite. The internal chains of crystals, called magnetosomes, make the bacteria desirable for commercial medical uses including magnetic cell sorting, drug delivery that can be targeted to specific body sites, and contrast enhancement of magnetic resonance images (MRI).

The newly discovered bacteria, named BW-1, produces a magnetic, iron-sulfide mineral, greigite (Fe3S4), in addition to a magnetic, iron-oxide mineral, magnetite (Fe3O4). Environmental factors determine which mineral develops. BW-1 is the first strain of bacteria found to produce both minerals.

Because greigite-producing bacteria have never before been isolated and grown in a lab, greigite crystals haven't been tested for use in the types of biomedical applications that currently use magnetite. Greigite may be superior to magnetite in some applications because of its slightly different physical and magnetic properties, according to the research paper.

As documented in the "Science Magazine" article, Bazylinski and post-doctoral fellow Christopher Lefèvre discovered BW-1 in water samples collected more than 280 feet below sea level in the Badwater Basin in Death Valley National Park. The duo then isolated and grew BW-1 in their lab.

Cal Poly's Frankel suggested the Badwater Basin to the UNLV team after finding magnetotactic bacteria there himself several years ago.

Frankel's participation in the study involved identification of the magnetosome minerals in BW-1 using an electron microscope and a process called electron diffraction. He also assisted in writing the research paper.

Frankel has studied and published papers on magnetotactic bacteria since 1979. "This is one of a series of papers on magnetotactic bacteria found in 'extreme' environments in springs, ponds, and lakes in California and Nevada," he said. "These waters are extreme in terms of temperature, pH balance or other factors."

While other greigite-producing bacteria were discovered 20 years ago, little is known about them and none have ever been cultivated in a lab. Many magnetite-producing bacteria are now grown in labs, and also used in biotechnology.

The team also found that BW-1 represents a new, previously unrecognized, group of bacteria known as sulfate-reducing bacteria that "breathe" sulfate instead of oxygen.

The study, "A Cultured Greigite-Producing Magnetotactic Bacterium in a Novel Group of Sulfate-Reducing Bacteria," was funded in part by a grant from the U.S. National Science Foundation, the U.S. Department of Energy and the French Foundation for Medical Research.

Partnering with Bazylinski, Lefèvre and Cal Poly's Frankel were: David Pignol of the Institute of Biology and Biotechnology, French National Center of Scientific Research and University of Aix-Marseille II (France); Nicolas Menguy of Pierre and Marie Curie University (France); Fernanda Abreu and Ulysses Lins of the Federal University of Rio de Janeiro (Brazil); Mihaly Pósfai of the University of Pannonia (Hungary); and Tanya Prozorov of the Ames National Laboratory, Iowa State University.

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