# Microbes turn mud into electricity

By Paula Hartman Cohen
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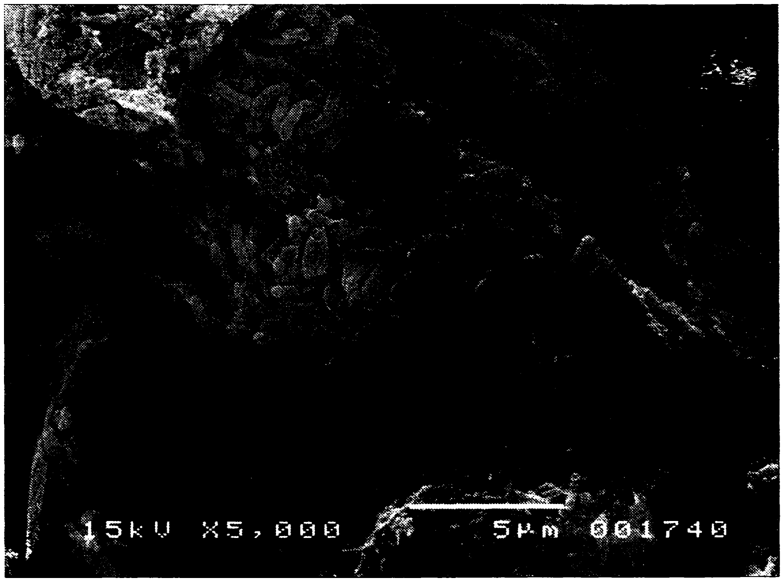
Will soldiers someday wear vests containing microbes that signal contact with biological weapons? Could unmanned submarines or underwater sensing devices run on microbe-power?

Research conducted by University microbiologists and reported in last week's issue of the journal Science concludes that certain microorganisms can transform organic matter commonly found at the bottom of the ocean into electrical energy. Aside from raising the possibility that microbes someday could be used to produce power in subsurface settings, the findings have implications for many industrial and military applications, according to microbiologist and team leader Derek R. Lovley. An understanding of how microbes generate and use electrical energy may also prompt the development of new technologies to decontaminate polluted water and sediment containing organic materials, including petroleum and other aromatic hydrocarbons, he says.



Researchers found a large number. ofthe Geobacter known ***asDesulfuromonas acetoxidans on*** the anode end of the primitive batteries used in the study. (Daniel Bond photo/Department of Microbiology)

In the Science article, Lovley explains how the team used water and sediment from Boston Harbor, a collection of mason jars, ordinary elec trical wirinig, and sterile graphite electrodes to determ ne the science behind the mechanics of a simple, sediment battery. The researchers added a layer of common mud to water in the jars, put one graphite electrode in the mud, another in overlying water. The resulting electrical current was strong enough to activate a light bulb, or a simple computer. "Even using a primitive electrode made from graphite," Lovley said, to produce enough current to power.

basic electronic marine instruments."

ore refined experiments, Lovley's group found that a family of energy-harvesting microorganisms, commonly referred to as Geobacters, were key to the production of the electrical current. Whereas most life forms, including humans, get their energy by oxidizing organic compounds with oxygen, Geobacters -,grow in environments lacking oxygen by using the iron naturally present in soil, in place of oxygen. This new research demonstrates that Geobacters can also substitute an unnatural substance, such as an elec, trode, for the iron, according to Lovley.

A large number of a Geobacter species known as ***Desulfuromonas acetoxidans (D. acetoxidans)*** were found on the anode end of the, primitive, batteries. When the researchers destroyed the D. ***acetoxidans*** in the sediment, the current stopped.

"In the mud, a community of microorganisms cooperates to break down larger, more complex organic compounds to acetate. Geobacters then transfer the electrons from the acetate to the electrode generating the electrical energy," he said.

Lovley's group also has found that some Geobacters can convert toxic organic compounds, such as toluene, to electricity. Lovley says this suggests that some Geobacters can be used to harvest energy from waste matter, or can be included in technology used to clean up subsurface environments contaminated by organic matter. especially petroleum. Earlier studies had shown bacteria could produce electricity under artificial conditions in which special chemicals were added. but the study was the first to prove that the nearly ubiquitous microbes living in a typical marine environment could produce electricity under the condi tions naturally found in that environment.

"Once we know more about the genome of Geobacters, we will be able to manipulate the isms to make them receptive to a variety of organic or inorganic contaminants. Theoretically, when they begin to degrade the contaminant, they will throw electrons on an electrode, and that could set off a light, a sound or some other form of signal," Lovley said. "An understanding of how this phenomenon operates has a number of extremely timely applications, especially in developing. technologies to recognize toxins and organic contaminants." Lovley cites, for example, the potential for using such technology to, develop., military equipment that could alert soldiers to the presence of toxins or biological warfare agents in the immediate environment.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The research team included postdoctoral researcher Daniel R. Bond and doctoral student Dawn E. Holmes, and Leonard M. Tender of the Naval Research Labora-tories.