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Super Microbe Cleans Up Uranium

By Kate Ruder

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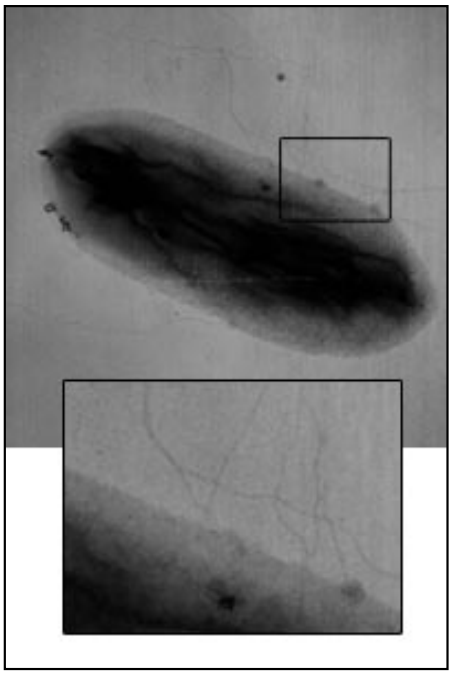
During the Cold War, the United States produced uranium for its nuclear weapons at Rifle Mill in Western Colorado. The mine closed in 1972, but the uranium has caused lasting effects on the area, despite clean-up efforts. Uranium remains underground today, and radioactive metal from the site is still contaminating groundwater that eventually flows into the Colorado River.

Wells at old Rifle mine inject acetate (vinegar) into the ground to stimulate the growth of microbes already in the soil.
Image courtesy D. Lovley.

But there may be a solution that's natural and efficient. Some microbes in the soil change metals such as uranium from a dangerous, soluble form to an insoluble form that falls out of the groundwater, where it could be collected and safely removed. The microbes live in the ground, and they can be stimulated to grow naturally by adding vinegar to the soil.

One such microbe is *Geobacter sulfurreducens*. Researchers funded by the U.S. Department of Energy have used the microbe to reduce uranium in the water at Rifle Mill by over 70 percent. And further research this past summer reduced uranium in water at the site by 90 percent.

Now, scientists have sequenced the genome of *G. sulfurreducens* and identified genes that may help make a more effective, fearsome microbe for cleaning up uranium at sites such as Rifle Mill and throughout the world. The findings are published today in *Science*.



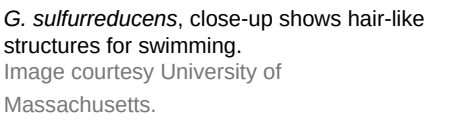
"The genome has fundamentally changed the way we think about this organism," says Barbara Methé, who led the sequencing at The Institute for Genomic Research (TIGR) in Rockville, Maryland.

They found over a hundred genes that help the microbe produce energy by transporting electrons to metals like uranium—the effects of this are what causes the uranium to drop out of water. Scientists want to better understand this process so that they can improve bioremediation strategies.

The scientists also found genes that help the microbe swim and "sniff-out" out metals. They discovered that *G. sulfurreducens* probably adapts to and competes in a variety of environments underground, including oxygen-poor soils and soils with oxygen.

Methé and her colleagues at TIGR have built DNA microarrays that contain the whole genome of *G. sulfurreducens*. Now she and Derek Lovley of the University of Massachusetts in Amherst are using these

arrays to test which genes are turned off and on when the microbe creates energy, in hopes of someday manipulating *Geobacter* to do this better and faster.



G. sulfurreducens, close-up shows hair-like structures for swimming.
Image courtesy University of Massachusetts.

The same process the microbe uses to make energy with metals such as uranium could be used to produce alternative sources of energy for batteries. Scientists have produced energy by hooking up *G. sulfurreducens* cells to electrodes and capturing the electric current.

You probably will never drive a *Geobacter*-powered car, but the microbe, which also lives in soil at the bottom of the ocean, could be used to power batteries for computers in hard-to-reach places such as the sea floor, where researchers want to install computers that would monitor ocean life.

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Meanwhile, *G. sulfurreducens* is not the only microbe with an affinity for decontaminating metals. Its cousin *Geobacter metallireducens* breaks down uranium *and* plutonium. Radioactive metals, beware.

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Methé, B.A. *et al.* Genome of *Geobacter sulfurreducens*: Metal Reduction in Subsurface Environments. *Science* **302**, 1967-1969 (December 12, 2003).

Anderson , R.T. *et al.* Stimulating the in situ activity of Geobacter species to remove uranium from the groundwater of a uranium-contaminated aquifer. *Applied and Environmental Microbiology* **69**, 5884-5891 (October 2003).

Bond, Daniel R. and Derek R. Lovley. Electricity production by *Geobacter sulfurreducens* attached to electrodes. *Applied and Environmental Microbiology* **69**, 1548-1555 (March 2003).

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