The Efficacy of Bacteria

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Marching to their own drummer. That’s what bacteria from different environments do when turning toxic, mobile selenium into a less dangerous, non-mobile form, according to a study led by Dr. Carolyn Pearce, formerly of the University of Manchester and now with Pacific Northwest National Laboratory.

(PhysOrg.com) -- Marching to their own drummer. That's what bacteria from different environments do when turning toxic, mobile selenium into a less dangerous, non-mobile form, according to a study led by Dr. Carolyn Pearce. Pearce, formerly of the University of Manchester, is now conducting her research at Pacific Northwest National Laboratory. The research she and her team did graced the November 2009 cover of *Environmental Technology*. This was a special issue for the Chalocogen Cycle Science and Technology Conference.

While the human body needs trace amounts of selenium, high levels in certain forms are poisonous. Humans and wildlife can encounter these toxic forms in crops grown in selenium-rich soil. Bacteria that thrive in the soil can prevent this scenario, by turning the hazardous selenium into a form that is ignored by the plants. This research shows which of three common bacteria are best at transforming the selenium.

The team began with pure strains of three different bacteria: *Geobacter sulfurreducens*, Shewanella oneidensis, and *Veillonella atypica*. When grown in an environment containing the selenium oxyanion, selenite, all three microbes turn this toxic, bioavailable form into less hazardous elemental selenium. The bacteria do this by shuttling electrons from an electron donor to the selenite. Adding electrons reduces the positively charged selenium to the elemental or uncharged form, which is less toxic, does not move through the soil, and is not readily available to plants. Using an array of complex instruments including a synchrotron beam and calculations, they determined how quickly each bacterial strain transformed the toxic selenite into tiny spheres or spikey crystals of elemental selenium.

Of the three bacteria, they found that Veillonella atypica was the most efficient at transforming the selenite. As they explored how this was done, they found that Veillonella atypica used a different process. While Geobacter and Shewanella turned the selenium into an intermediate crystalline form, Veillonella did not create an intermediate crystalline form.

With these experiments complete, the team conducted a second set of experiments. This time they added an electron mediator, a chemical that makes it easier for the microbes to shuttle electrons around. They found that adding this mediator speeded the reactions for each of the microbes.

Finally, they studied the bacterial proteins associated with the formation of the nontoxic selenium. They found that a type of proteins that reside on the bacteria's surface, called c-type cytochromes, are involved. This type of protein has been linked to similar reactions involving Shewanella and uranium in another study.

"It is useful to do these studies to work out the fate of selenium in the environment," said Pearce. "If the soil is dominated by Geobacter, you'll get one type of a reaction, but a different one with Shewanella."

Pearce is now studying how microbes halt the subsurface migration of nuclear weapons industry byproducts technetium and uranium. In addition, Pearce and her associates are examining the effect of minerals on the mobility and availability of the radionuclides. Understanding how microbes and minerals behave is a vital step to controlling their interactions with the environment and creating safe, effective cleanup technologies.

Much of Pearce's work is done using resources at the Department of Energy's EMSL, a national scientific user facility at PNNL.

More information: Pearce CI, RAD Pattrick, N Law, JM Charnock, VS Coker, JW Fellowes, RS Oremland, and JR Lloyd. 2009. "Investigating different mechanisms for biogenic selenite transformations: Geobacter sulfurreducens, Shewanella oneidensis and Veillonella atypica." *Environmental Technology* 30(12):1313-1326.

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