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'Gold bug' sheds new light on old question

Lovley uses pollution cleanup technology to explain gold deposits

by Paula Hartman Cohen, News Office Staff


Derek Lovley in his laboratory (Stan Sherer photo)

For centuries, scientists have wondered why gold is found in two forms - as a solid in deposits close to the Earth's crust, and in solution, often far removed from gold-ore deposits. A fairly simple lab experiment conducted by University microbiologists may lead to an understanding of how the precious metal came to be available in disparate forms, and how some gold-ore deposits might have been formed.

In research related to pollution cleanup, a team of scientists led by researcher Derek Lovley has extracted gold solids from water containing dissolved gold. The work uses technology Lovley developed 10 years ago to clean up heavily polluted water and soil around the U.S. using bacteria and archaea, or ancient micro-organisms, to break down heavy metals in affected environments.

Like uranium, cadmium, and other heavy metals, gold is precious and useful to humans. Lovley notes that dissolved gold, however, is useless because it can't be manipulated and formed into objects of value or beauty. He says when either solid or liquid gold is ingested, it is toxic to most life forms. On the other hand, liquid gold and many other heavy metals are not toxic to a group of microbes called extremophiles, or simple life forms known to thrive in environments where others cannot live.

With this in mind, the researchers asked if extremophiles might have ingested the liquid gold found in hydrothermal vents, hot springs, and other hot places, and left it scattered as deposits of solid gold in places that now are below the surface of the Earth. This would explain how the metal came to be in two different forms in very different environments. If that is the case, the team wondered if microbes could duplicate the process in the laboratory and extract valuable solids from liquid containing dissolved gold.

"A vast number of bacteria and archaea have the ability to transfer electrons to iron through a reduction process," explained Lovley. "In other words, they digest one form of a metal and excrete it as another form. This transfer leaves behind deposits of solid metal in unlikely places on Earth or maybe even on Mars. What's left behind is often more useful, or more accessible to humans, than the original form of the same substance."

Lovley's lab has previously published evidence that iron-reducing micro-organisms are involved in the formation of uranium ores, changing uranium to a form that precipitates out of water. Massive accumulations of magnetite created by iron-reducing microbes during the Precambrian period of the earth's development now are important deposits of iron ore, according to Lovley.

In the laboratory, postdoctoral research associate Kazem Kashefi, and graduate students Jason M. Tor, and Kelly P. Nevin studied dissolved gold in an oxidized form in an environment similar to that found in a hydrothermal vent, where dissolved gold can sometimes be found.

The team wanted to see what would happen if they put iron-reducing microbes into the gold solution under those conditions. As they suspected, the microbes rapidly converted the gold from the useless, oxidized, dissolved form to a more valuable, insoluble, metal form. Essentially, the microbes had eaten the solution, and left behind a precious byproduct.

"There's a significant amount of gold found in solution in some thermal springs, and hydrothermal vents on the ocean floor," Lovley said. "The problem is that the gold is extremely diluted, so only a teeny amount is dispersed in a very large volume of water."

"There are waste streams from gold processing where this same reduction process might work on a larger scale, but the goal of this study was to offer an explanation of how gold deposits are formed, more than it was to produce any profitable or useful application on a larger scale," explained Lovley. The research was presented in the July issue of the journal Applied and Environmental Microbiology. It was funded in part by a grant from the National Science Foundation, through the Life in Extreme Environments Program.