Gold-digging bacterium makes precious particles

Biochemical trick could aid in recovery of the metal from waste.

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Gold prospectors may one day use Petri dishes to help with their quests. A species of bacterium forms nanoscale gold nuggets to help it to grow in toxic solutions of the precious metal, reports a paper published online today in *Nature Chemical Biology*[1].

Bertrand Rieger/Hemis/Corbis

Gold nuggets host bacteria that use biochemical tricks to bypass the metal's toxicity.

The molecule with which the bacteria create the particles could one day be used to collect gold from mine waste, says Frank Reith, an environmental microbiologist at the University of Adelaide in Australia, who works on gold-processing bacteria but was not involved in the latest study.

Reith found some of the first convincing evidence that bacteria thrive on gold particles about ten years ago. At multiple sites, thousands of kilometres apart, he and his team found the bacterium *Cupriavidus metallidurans* living in biofilms on gold nuggets. The bacteria detoxify dissolved gold by accumulating it in inert nanoparticles inside their cells[2]; Reith and his colleagues have spent the past decade working out how, but have not yet published their complete conclusions.

Some biofilms also contained a second species of bacterium: *Delftia acidovarans*. Nathan Magarvey, a biochemist at McMaster University in Hamilton, Canada, and his team grew this species in the presence of a gold solution and discovered that the bacterial colonies were surrounded by dark haloes of gold nanoparticles. The researchers concluded that *D. acidovarans* was somehow creating gold particles outside its cell wall, instead of inside as *C. metallidurans* does.

Golden genes

Using biochemical and genome analysis, the researchers discovered a set of genes and a chemical metabolite that were responsible for precipitating the gold. Bacteria engineered to lack the genes no longer formed dark haloes, and their growth was stunted in the presence of gold. The team also isolated a chemical produced by the unengineered bacteria that caused gold particles to precipitate out of a solution. The chemical was dubbed delftibactin.

The researchers suggest that the genes they identified are involved in producing delftibactin and shunting it outside the cell. By precipitating gold, *D. acidovarans* may keep the metal from entering its cells in solution. But Magarvey says that it is possible that *D. acidovarans* also uses other mechanisms to detoxify gold that breaches its cell walls.

Margarvey's work “complements ours really well”, says Reith. The two bacterial species might live in symbiosis, with *D. acidovarans* using delftibactin to diminish the soluble gold to levels that both species can cope with.

A microbe-assisted gold rush might yet happen, says Reith. Delftibactin could be used to produce gold-nanoparticle catalysts for many chemical reactions, or to precipitate gold from waste water produced at mines. “The idea could be to use a bacterium or metabolite to seed these waste-drop piles, leave them standing for years, and see if bigger particles form,” says Reith.

Magarvey takes those applications seriously: he has secured intellectual-property rights for delftibactin. But he emphasizes that he is most interested in understanding the metabolite's chemical properties. “I wish I could say we’re up here in Canada growing kilos of gold everyday.”

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References

1. Johnston, C. W. et al. *Nature Chem. Biol.* http://dx.doi.org/10.1038/nchembio.1179 (2013).

2. Reith, F. *et al*. *Proc. Natl Acad. Sci. USA* **106**, 17757–17762 (2009).