Ancient microbes formed Earth's biggest hoard of gold

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The process could only have taken place during a window of opportunity after life on land came to being and before it created the planet's oxygen-rich atmosphere. This means such gold deposits could not be formed today – but it potentially gives us a new way to find them.

Approximately 40,000 metric tonnes of gold have been mined from the Witwatersrand Basin in South Africa since its discovery in 1886. That's three times more than from any other single source and roughly half the gold ever been mined on Earth.

The gold accumulated 3 billion years ago. But how it did so has been a matter of geological debate.

Golden eruption

There's little doubt that the gold first reached the Earth's surface through the erosion of gold-bearing veins in a granite mountain range called the Kaapvaal Craton in what is now north-east South Africa. The precious metal came up with the lava that formed the mountains.

But it is unclear how huge quantities of this gold ended up several hundred kilometres to the south west in the Witwatersrand basin.

The prevailing theory is that metallic gold fragments were eroded from the Craton mountains and transported by rivers that dumped their cargo in shallow lakes overlying what is now the

gold-rich basin.

"The idea is that it arrived by mechanical transportation together with sediments, like gold washing into creeks and gullies," says Christoph Heinrich of the Swiss Federal Institute of Technology in Zurich, Switzerland. He disagrees.

Heinrich argues that the gold was first dissolved chemically by volcanic rain and then washed to the basins by river. It was then precipitated out of the water by mats of microbes growing in shallow pools of the Basin.

"We don't know if the gold precipitated out during life or after they died, but basic chemistry tells us that organic life reduces gold chemically from the ionic to the elemental form," Heinrich says.

No oxygen

Central to his theory is that 3 billion years ago, the atmosphere was still largely free of the oxygen that was produced half a billion years later by algae and cyanobacteria during the Great Oxidation Event.

Before this event, the air was full of gases containing sulphur – such as hydrogen sulphide – that were pumped out by volcanoes and rained down on the mountains in acid rain. The gold would have formed soluble complexes with sulphur, which were then absorbed in water and finally separated by the primitive microbes, leaving behind today's rich legacy of elemental gold.

This was only possible because there was so little oxygen in the atmosphere at the time, says Heinrich. If oxygen had been there, it would have reacted with and destroyed the sulphide-based gold complexes before they could reach the shallow, life-bearing pools. "Oxygen would have 'killed' the sulphur compounds that carried the gold," he says.

"The billion-dollar question is whether the same process created other gold deposits," says Heinrich.

If it did, then it may provide new geological clues for today's gold prospectors. Currently, he says that searches tend to focus on gravel-rich areas like those that gave rise to the Californian gold rush. But if gold was transported in solution rather than as grains, and later extracted by early life forms, this may open up new ways to trace untapped deposits, he says.

So where would he look for gold? "I would look for carbon because if I'm right, carbon is an essential part of it," says Heinrich. "So I would maybe look for carbon-rich shale in the same lake-type environments but without the gravel."

Heinrich's theory is worth serious consideration and further testing, says Jan Kramers of the University of Johannesburg in South Africa. "It works well with the now well-established observation that the atmosphere was not oxidising and the rain was more acidic than today, and it's hard to fault the arguments for transport of gold in solution under these conditions, followed by precipitation in the presence of organic matter."

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