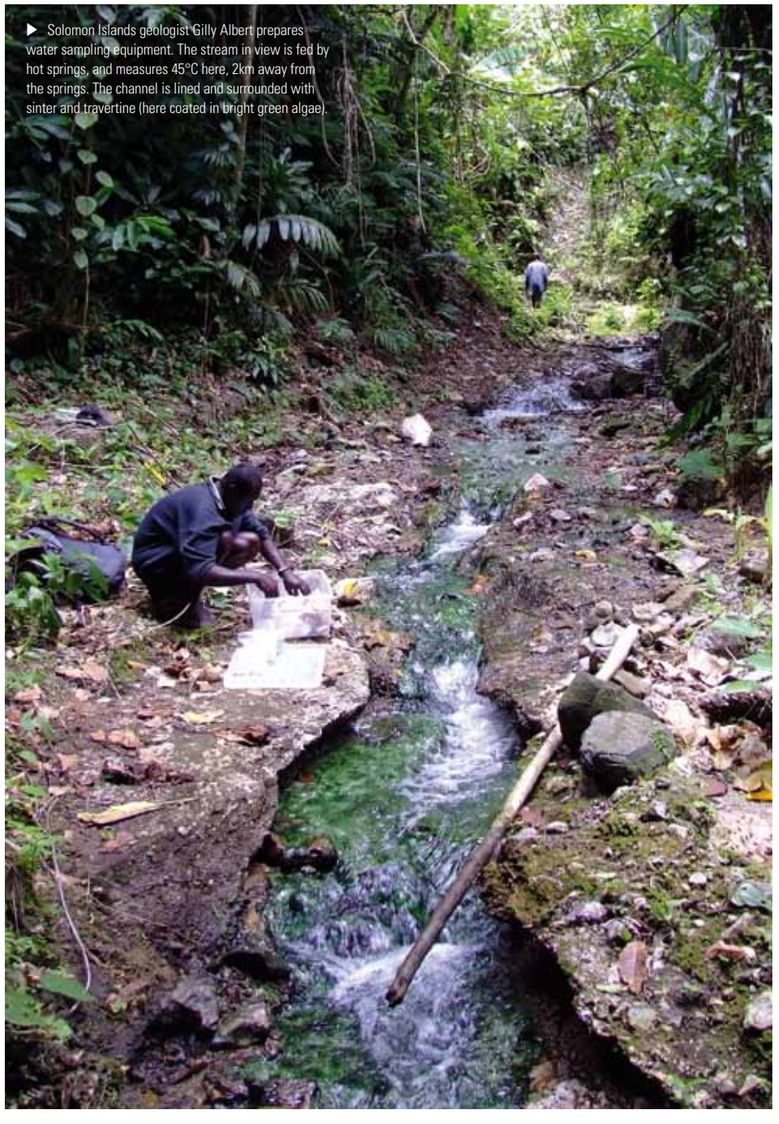
Finding Solomon's gold?

Finding gold deposits isn't easy in heavily forested tropical regions. Dan Smith, Gawen Jenkin and Jon Naden describe how precipitates from hot springs could lead us to a gold mine beneath.



▶ Solomon Islands geologist Gilly Albert prepares water sampling equipment. The stream in view is fed by hot springs, and measures 45°C here, 2km away from the springs. The channel is lined and surrounded with sinter and travertine (here coated in bright green algae).

In 1567, the Spanish explorer Álvaro de Mendaña discovered an island chain in the South Pacific. Finding traces of gold in the streams that washed from the highlands, he believed he had stumbled on a nation of unimaginable wealth. He decided to christen the archipelago the Solomon Islands, after the biblical king and his fabled wealth.

But despite early indications, the generations following Mendaña have found little gold in the Solomons. Despite small discoveries, the gold has remained largely elusive – perhaps because deposits are difficult to find in the heavily forested islands. But the rewards for finding gold can be enormous – a single deposit can be worth billions of pounds.

Our team, including researchers from the University of Leicester and the British Geological Survey (BGS), didn't set out to find gold though. We were looking for something far more common – seawater.

Savo volcano is young, having last erupted in the mid-nineteenth century. Only the upper third of the volcanic cone is above sea level, forming Savo Island. Numerous hot springs and steam vents around the island discharge boiling water and superheated steam – in some places only a few metres above sea level. We were investigating these springs, to see whether they contained seawater. We knew this played an important role in the formation of the Emperor gold deposit in nearby Fiji – could Savo be a modern, active example of a seawater-volcanic system?

The answer was a resounding 'no'. Much like the fabled wealth of Solomon, seawater can't be found in Savo's springs. Using a variety of tracers for seawater (including stable isotopes of oxygen, hydrogen and sulphur, strontium isotopes, and fluid salinity), it became clear it hadn't made its way into the hot springs. Instead, we found the springs were dominated by rainwater and volcanic gases, and contained elements leached out of the volcanic rocks.

Another surprise was that Savo's springs are slightly alkaline – very unusual for water containing acidic volcanic gases. Around them, precipitates of sinter (silica from cooling waters) and travertine (calcium carbonate) occur, often interlayered or even intimately mixed.

This is unusual in itself – the two precipitate types are traditionally considered to form from different fluids – sinter from high temperature, deeply sourced waters, and travertine from shallow, cooler waters produced from rainwater and volcanic CO_2. These mixed precipitates suggest the cool carbonate waters mix with and dilute high-temperature fluid released from magma at depth; the fluids became alkaline by reacting with the surrounding volcanic rocks.

Gold in those hills

And then we found some gold! Chemical analysis of the hot spring precipitates showed gold present at concentrations of a few parts per billion. This is a tiny amount, but significant given that the precipitates formed from dilute water. Along with the gold were elevated levels of tellurium, an element that is strongly associated with volcanic-hosted gold deposits.

It is one of the rarest elements at the Earth's surface. Fewer than five parts per billion are typically present in most rocks, but the hot spring precipitates at Savo contain up to 100 times more. Rare samples of material erupted from deeper parts of Savo contain up to one part per million (ppm) gold, as well as high tellurium, and can be chemically related to the springs at the surface. If there is enough of it, rock with 1ppm gold can be economically mined, so our results hint that Savo could form a gold deposit.

The chemistry of the hot spring precipitates is a key find. The presence of the tellurium and trace gold is a good indicator of the overall nature of the system – a mixture of rainwater and high temperature fluids from magma at depth. Such precipitates may help us locate similar systems elsewhere, including those with commercially viable gold. Given that the precipitates form by the simple process of hotter waters mixing with cooler rain-derived groundwater, the chances of finding them elsewhere are good.

◀ Steam billows from vents and boiling springs at one of the major thermal areas on Savo.

▼ Dan Smith sampling fluids from boiling springs and steam vents on Savo.

This type of hot spring precipitate may help mineral exploration geologists in the South Pacific find potential gold deposits. These form at the top of the system, so erosion is not necessary to expose them – a critical factor given that volcanic systems in this part of the world are too young to have been eroded much yet. The precipitates are found lining stream channels, and are not usually hidden by vegetation. Rock exposure is limited by dense jungle and rainforest across much of the Solomon Islands, making a geologist's job that much more difficult. Being able to identify a potential gold-hosting volcanic system based on a set of well-exposed rocks is extremely useful.

In terms of social relevance, finding and using mineral resources is important for the economic development of the Solomon Islands and many other developing nations. The Gold Ridge Mine, on Guadalcanal in the central Solomons, generated an estimated 30 per cent of the country's GDP in 1998–2000. Discovery of even a modest-sized deposit such as Gold Ridge can mean a massive injection of wealth into the economy.

It seems that King Solomon's riches will remain hidden for a little while longer, but the islands that bear his name are providing insight into how gold deposits form in the South Pacific, and how systems hosting gold are expressed at the surface. Our study at Savo has identified unusual hot spring precipitates which provide chemical evidence of the system beneath, and may be useful as tracers for similar activity elsewhere. It is perhaps fitting, given the ancient king's story, that we find wisdom before the wealth.

MORE INFORMATION

Dr Dan Smith recently completed a NERC CASE PhD on the Savo volcano in the Solomon Islands with BGS and is now working in its Carbon Capture and Storage team. Email: dani1@bgs.ac.uk.
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Dr Jon Naden is an economic geologist at the BGS and works in the Minerals for Development team.

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FURTHER READING

Smith DJ, Jenkin GRT, Naden J, Petterson MG, Boyce AJ & Toba T (2009). Sinter and travertine deposits from volcanic hot springs and their potential in exploration. *Applied Earth Science* (*Trans. Inst. Min. Metall. B*), 118, 36-37.