Do we finally have proof of life on Mars?

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In the past few months, conclusive evidence has been found that Mars once had water on its surface, but one greater question remains: was there, or is there still, life on Mars as well?

Scientists may be on the brink of answering that question with an equally conclusive 'yes', as convincing evidence has been detected by NASA's Curiosity rover.

An instrument on the rover identified spikes of methane that scientists believe may have come from bacteria-like organisms on the surface – and it could be the first alien life ever detected.

"This temporary increase in methane – sharply up and then back down – tells us there must be some relatively localised source," said Sushil Atreya of the University of Michigan, Ann Arbor, and Curiosity rover science team.

"There are many possible sources, biological or non-biological, such as interaction of water and rock."

Previous satellite observations have detected unusual plumes of methane on the planet. But none of these previous readings are as extraordinary as the sudden 'venting' measured at Gale Crater, where evidence suggests water once flowed billions of years ago. Curiosity landed in the 154km crater in August 2012 and has been exploring the region ever since.

Recently, NASA reported that Gale contained the remains of an ancient freshwater lake where there may have been a hospitable environment for life in the distant past.

The new discovery, reported in the journal Science, followed studies of gas samples by Curiosity's Tunable Laser Spectrometer (TLS) – an instrument that uses intense light to carry out chemical analysis.

It revealed a low background level of methane, which spiked 10-fold over a period of just 60 Martian days.

In four sequential measurements, Curiosity showed the methane level soaring from about 0.69 parts per billion by volume (ppbv) to 7.2 ppbv.

The spikes occurred within 200 to 300 metres of each other and less than 1km from where the lower readings were detected.

By the time Curiosity had travelled a further kilometre, the higher methane levels had disappeared.

In their paper, the US scientists led by Dr Chris Webster, from Nasa's Jet Propulsion Laboratory in Pasadena, California, wrote: 'The persistence of the high methane values over 60 sols (Martian days) and their sudden drop 47 sols later is not consistent with a well-mixed event, but rather with a local production or venting that, once terminated, disperses quickly.'

The wind direction indicated a source to the north of the rover.

Life is the chief producer of methane on Earth, but there are many non-biological processes that can also generate the gas.

The low background level of methane detected by Curiosity can be explained by the sun's rays degrading organic material possibly deposited by meteors, said the NASA scientists.

But the spikes of methane required an additional source, which was unlikely to be a recent impact by comet or asteroid.

Such an object would have had to measure several metres across and would have left a large crater – no sign of which was visible.

The short time-scale of the methane spikes did not suggest that the gas was released from volcanic deposits trapped in ice, called clathrates either. Nor did it appear to come from the release of gaseous methane that had become bound to the soil.

The NASA authors are cautious about jumping to conclusions, but conclude that 'methanogenesis' – the formation of methane by microbial bugs known as methanogens – may be one answer to the riddle.

They wrote: 'Our measurements spanning a full Mars year indicate that trace quantities of methane are being generated on Mars by more than one mechanism or a combination of proposed mechanisms – including methanogenesis either today or released from past reservoirs, or both.'

Gale Crater, on the Martian equator, was created when a large meteor struck the planet 3.5 billion to 3.8 billion years ago.

At its centre is a high mountain, named Mount Sharp, that rises 5,500 metres above the crater floor.

Flowing water appears to have carved channels in the sides of the mountain and the crater walls.

Another major discovery by Curiosity was that of water bound in the fine-grained soil within the crater.

Each cubic foot of Martian soil was found to contain around two pints

of water, not freely accessible but

attached to minerals.

Curiosity also detected different Martian organic chemicals in powder drilled from a rock dubbed Cumberland, the first definitive detection of organics in surface materials of Mars. These Martian organics could either have formed on Mars or been delivered to Mars by meteorites.

“This first confirmation of organic carbon in a rock on Mars holds much promise,” said Curiosity participating scientist Roger Summons of the Massachusetts Institute of Technology in Cambridge.

“Organics are important because they can tell us about the chemical pathways by, which they were formed and preserved.”