Missing methane gas mystifies Mars scientists

Curiosity rover fails to detect previously recorded chemical in Martian atmosphere.

Mark Peplow

19 September 2013

The Mars rover Curiosity has not found any methane in the planet's atmosphere[1], raising doubts about plumes of the gas that once tantalized planetary scientists.

NASA/JPL-Caltech/Malin Space Science Systems

The Curiosity rover is checking Mars for signs of methane gas, among other things.

In 2004, three research teams said that they had spotted whiffs of methane on the red planet. The gas could have come from Martian microbes or geological activity, or been delivered by crashing comets — all thrilling possibilities. Ground-based telescopes in Hawaii, as well as the European Space Agency (ESA) Mars Express probe, recorded varying amounts of methane, from 10 to about 45 parts per billion (p.p.b.) by volume of the atmosphere.

Methane molecules were expected to take centuries to break down in Mars's air, so researchers reasoned that the gas must have been produced within the past few hundred years. The most detailed investigation, led by Michael Mumma, a planetary scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, even identified plumes of methane coming from discrete hotspots on the Martian surface. The largest belch contained more than 17,000 tonnes of the gas[2].

Once dispersed, that plume should have left a background level of about 6 p.p.b. methane throughout the Martian atmosphere.

But Curiosity detected no signs of methane in three tests in October and November 2012, suggesting that the atmosphere held no more than 3 p.p.b. of the gas.

***Nature* special:**
Mars Curiosity rover

The rover did three further tests in June, and still found no methane. Together, the six results mean that there is no more than 1.3 p.p.b. of methane in Mars' atmosphere. Not only is methane not being produced in significant quantities — it might never have been there at all. The findings are published today in *Science*[1].

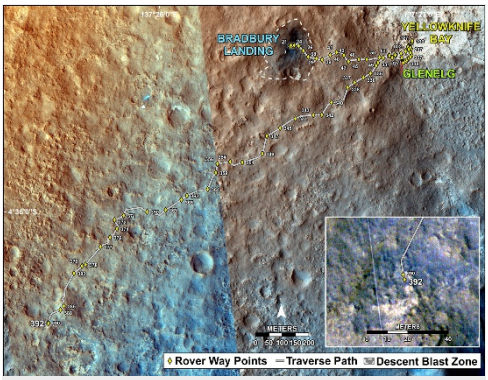
"It was a surprise and a disappointment," says Chris Webster, manager of the Planetary Sciences Instruments Office at NASA's Jet Propulsion Laboratory in Pasadena, California, and the scientist in charge of Curiosity's methane-seeking spectrometer.

Plume today, gone tomorrow

Mumma, too, has failed to see strong methane signals in recent measurements. That might be because atmospheric methane is destroyed much more quickly than expected, in mere weeks or months. Several mechanisms for such rapid decomposition have been proposed — including oxidation by soil chemicals called perchlorates — but there is no hard evidence for any of them. "It's a puzzle," says Mumma. "I haven't yet heard a convincing geochemical explanation."

Others question the original observations. "I never thought there was a good case for methane being there," says Kevin Zahnle, a planetologist at NASA Ames Research Center in Moffett Field, California. He argues that Mumma's original observations were muddied by signals from methane in Earth's own atmosphere, specifically from methane molecules containing a heavy isotope of carbon[3] (see 'Curiosity set to weigh in on Mars methane puzzle').

He also doubts that the methane could be destroyed so quickly. "On Earth, methane is a pretty robust molecule," he says. "That makes



NASA/JPL-Caltech/Univ. Arizona

The Curiosity rover landed on Mars in August 2012. By 13 September 2013, some 392 Martian days into its mission, it had driven almost 3 kilometres.

So could the methane plumes have been phantoms? “That’s a possibility,” concedes Mumma. But he says he has rebutted Zahnle’s arguments[4], adding that his team hunted for errors in its original observations, and found no reason to doubt them.

Despite the lack of methane signals, Webster and Zahnle agree with Mumma that it is too early to call off the hunt. The Indian Space Research Organisation is preparing an orbiting Mars probe that will check for methane, and is set for launch in October or November. ESA’s ExoMars Trace Gas Orbiter is scheduled to follow in 2016. However, neither can match Curiosity’s methane sensitivity.

The rover will perform more sensitive tests for methane in just a few months' time. It will filter carbon dioxide out of Martian air samples and concentrate the remainder, which should allow it to register traces of methane at concentrations as low as 50 parts per trillion. “It’s still early days, and Mars is full of surprises,” says Webster. “Should methane arrive in the future, we will detect it.”

Nature | doi:10.1038/nature.2013.13779

References

1. Webster, C. R. *et al*. *Science* http://dx.doi.org/10.1126/science.1242902 (2013).
2. Mumma, M. J. *et al*. *Science* **323**, 1041–1045 (2009).
3. Zahnle, K., Freedman, R. S. & Catling, D. C. *Icarus* **212**, 493–503 (2011).
4. Villanueva, G. L. *et al*. *Icarus* **223**, 11–27 (2013).