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Martian Methane Resuscitates Hope for Life on the Red Planet

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Image: NASA GLENN RESEARCH CENTER

It has been a while since you heard planetary scientists seriously talking about life on Mars. From the forbidding conditions revealed by the Viking landers of the mid-70s, to doubts about the origins of riverlike formations, to the meteoric rise and fall of the case for fossils in a Martian meteorite, researchers have learned the hard way not to get their hopes up.

So as several research teams announced over the past year that they had seen methane gas in the Martian atmosphere, the response has been so cautious that you'd hardly know just how revolutionary the discovery might be. For decades, methane has been near the top of scientists' list of biomarkers (substances whose presence is a possible sign of life). The idea of finding it on Mars seems so unlikely that many researchers assumed the discovery had to be some sort of mistake.

That reaction is no longer tenable. Last Thursday, at the annual meeting of the American Astronomical Society's Division for Planetary Science (DPS), planetary astronomer Michael Mumma of NASA's Goddard Space Flight Center announced hard-to-dispute evidence that the gas is really there. It may yet turn out to be nonbiological, but a living, breathing source is just as plausible. "I'll tell you quite honestly, I'm shocked," Mumma said to his colleagues. "We were not expecting this."

What makes methane so interesting is that the gas is unstable. On Earth, a methane molecule released into the air typically gets broken down by solar ultraviolet radiation in about 10 years. On Mars, farther from the sun, it lasts about 300 years. The persistence of the gas in our atmosphere indicates it is being replenished--in Earth's case, mostly by bacteria.

Observers have looked for methane on Mars for decades, but the best they could manage was a null result, which implied that the gas concentration could be no more than about 20 parts per billion (ppb). At the DPS meeting in 2003, Mumma announced the first hints of a positive detection, based on data taken earlier that year at two ground-based telescopes: NASA's Infrared Telescope Facility in Hawaii and the Gemini South telescope in Chile. Mumma issued no press releases and asked the few reporters who noticed his result to hold off publicizing it until he and his colleagues confirmed it.

Before he could do so, two other groups went public. One, led by Vladimir Krasnopolsky of Catholic University and his colleagues, took its data at the Canada-France-Hawaii Telescope in 1999. The other, led by Vittorio Formisano of Italy's Institute of Physics and Interplanetary Space, used an instrument on the European Space Agency's Mars Express spacecraft. Both found a gas concentration of 10 ppb averaged over a hemisphere. Mars Express was also able to focus on specific regions on the planet and uncovered concentrations ranging up to 40 ppb.

But Kransnopolsky's detection barely peeped out above the measurement noise, and both findings relied on a single spectral line, which could have been mimicked by other gases. The beauty of the work by Mumma's team is that the Gemini telescope data have revealed methane in two distinct spectral lines, with an impressive signal-to-noise ratio of 20. "This cannot be waved away by measurement error," he says.

What elevates the confirmation from gratifying to astounding is the sheer quantity of methane that Mumma and his colleagues found. They probed a range of longitudes and latitudes around such famous regions as Valles Marineris, Hellas Basin, and Elysium Planitia. At high latitudes, they measured 50 ppb or so; near the equator, 250 ppb or greater. Those values are quite a bit higher than the other groups' findings. Mumma and others say the discrepancy may simply reflect differences in how the teams averaged their measurements. The high concentrations in the Martian tropics suggest that methane is actively venting out there. Mumma says: "I think it may be methane that is being released from below the permafrost layer, percolating upward, and is being stopped, moving sideways and coming out the faces of cliffs."

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Where the stuff originates is still a mystery. Krasnopolsky leans toward a biological interpretation. He calculates that the methane concentration could be produced by a deeply buried bacterial ecosystem weighing 20 tons, which may sound like a lot of bacteria but actually is minuscule on a planetary scale. It amounts to a few oases of bugs toughing it out on an inhospitable world, which would match up with what scientists know about Mars.

Sushil Atreya of the University of Michigan, a member of the Mars Express team, says critters are possible but hardly definite. He argues that geothermal processes could do the trick. At a temperature of 100 degrees Celsius, which is naturally achieved underground on Mars, water can react with iron- or magnesium-rich rock to release hydrogen, which then combines with carbon dioxide to yield methane. Such a mechanism might also operate on the Saturnian satellite Titan, which also has an abundance of methane that has yet to be explained.

Mars Express is continuing to gather data. By the end of 2005, it should have completed a methane map for the whole planet. The probe will also peer into the subsurface with its radar. The beam can penetrate several kilometers down, more than enough to reach the depth at which hydrothermal activity should occur.

Ultimately, however, pinning down the source of the methane will probably require measurements of the isotopic variants of methane, which is hard to do from Earth or Mars orbit but should be possible with landers or special spaceborne telescopes now on the drawing board. Thoughts of a living Mars will tantalize planetary scientists for years to come. --*George Musser*

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