The Red Planet is Not a Dead Planet

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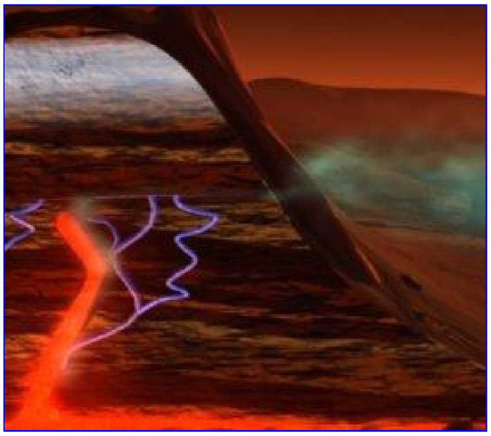
Jan. 15, 2009: Mars today is a world of cold and lonely deserts, apparently without life of any kind, at least on the surface. Indeed it looks like Mars has been cold and dry for billions of years, with an atmosphere so thin, any liquid water on the surface quickly boils away while the sun's ultraviolet radiation scorches the ground.

The situation sounds bleak, but research published today in *Science Express* reveals new hope for the Red Planet. The first definitive detection of methane in the atmosphere of Mars indicates that Mars is still alive, in either a biologic or geologic sense, according to a team of NASA and university scientists.

"Methane is quickly destroyed in the Martian atmosphere in a variety of ways, so our discovery of substantial plumes of methane in the northern hemisphere of Mars in 2003 indicates some ongoing process is releasing the gas," says lead author Michael Mumma of NASA's Goddard Space Flight Center. "At northern mid-summer, methane is released at a rate comparable to that of the massive hydrocarbon seep at Coal Oil Point in Santa Barbara, Calif."



Right: An artist's concept of a possible geological source of Martian methane: subsurface water, carbon dioxide and the planet's internal heat combine to release the gas. [animation]

Methane -- four atoms of hydrogen bound to a carbon atom -- is the main component of natural gas on Earth. It is of interest to astrobiologists because much of Earth's methane come from living organisms digesting their nutrients. However, life is not required to produce the gas. Other purely geological processes, like oxidation of iron, also release methane. "Right now, we don't have enough information to tell if biology or geology -- or both -- is producing the methane on Mars," said Mumma. "But it does tell us that the planet is still alive, at least in a geologic sense. It's as if Mars is challenging us, saying, hey, find out what this means."

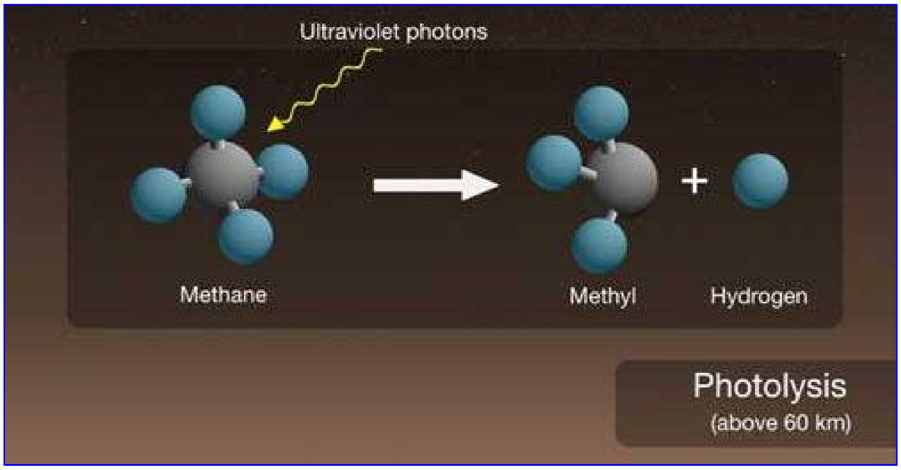
If microscopic Martian life is producing the methane, it likely resides far below the surface, where it's still warm enough for liquid water to exist. Liquid water, as well as energy sources and a supply of carbon, are necessary for all known forms of life.

"On Earth, microorganisms thrive 2 to 3 kilometers (about 1.2 to 1.9 miles) beneath the Witwatersrand basin of South Africa, where natural radioactivity splits water molecules into molecular hydrogen (H_2) and oxygen (O). The organisms use the hydrogen for energy. It might be possible for similar organisms to survive for billions of years below the permafrost layer on Mars, where water is liquid, radiation supplies energy, and carbon dioxide provides carbon," says Mumma.

"Gases, like methane, accumulated in such underground zones might be released into the atmosphere if pores or fissures open during the warm seasons, connecting the deep zones to the atmosphere at crater walls or canyons," he says.

"Microbes that produced methane from hydrogen and carbon dioxide were one of the earliest forms of life on Earth," notes Carl Pilcher, Director of the NASA Astrobiology Institute which partially supported the research. "If life ever existed on Mars, it's reasonable to think that its metabolism might have involved making methane from

Martian atmospheric carbon dioxide."

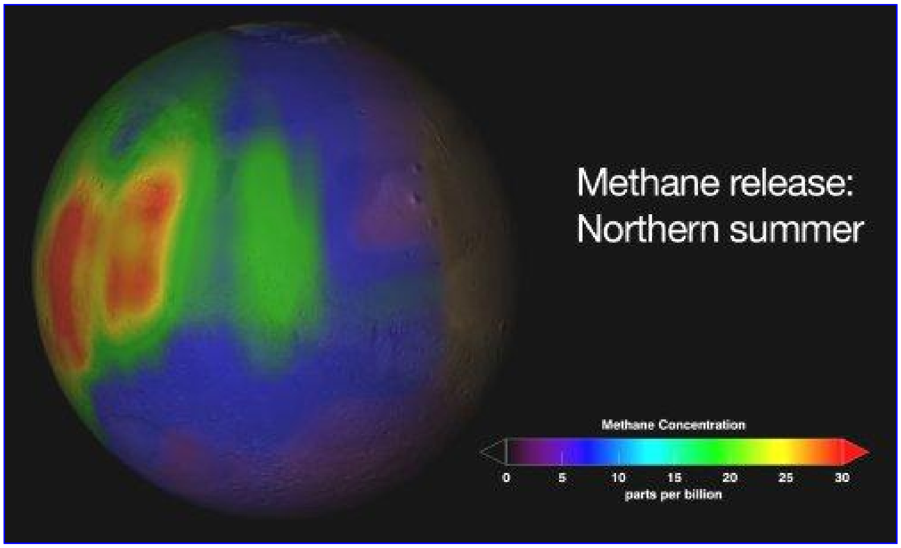


Above: This graphic shows one way methane is destroyed in the Martian atmosphere: the molecules are rapidly broken apart by solar ultraviolet radiation. Because methane doesn't last long in the martian environment, any methane found there must be recently produced. [animation]

However, it is possible a geologic process produced the Martian methane, either now or eons ago. On Earth, the conversion of iron oxide (rust) into the serpentine group of minerals creates methane, and on Mars this process could proceed using water, carbon dioxide, and the planet's internal heat. Another possibility is vulcanism: Although there is no evidence of currently active Martian volcanoes, ancient methane trapped in ice "cages" called clathrates might now be released.

The team found methane in the atmosphere of Mars by carefully observing the planet over several Mars years (and all Martian seasons) using spectrometers attached to telescopes at NASA's Infrared Telescope Facility, run by the University of Hawaii, and the W. M. Keck telescope, both at Mauna Kea, Hawaii.

"We observed and mapped multiple plumes of methane on Mars, one of which released about 19,000 metric tons of methane," says Geronimo Villanueva of the Catholic University of America in Washington, D.C. Villanueva is stationed at NASA Goddard and is co-author of the paper. "The plumes were emitted during the warmer seasons -- spring and summer -- perhaps because the permafrost blocking cracks and fissures vaporized, allowing methane to seep into the Martian air. Curiously, some plumes had water vapor while others did not," he says.



Above: Methane plumes found in Mars' atmosphere during the northern summer season. Credit: Trent Schindler/NASA [animation]

According to the team, the plumes were seen over areas that show evidence of ancient ground ice or flowing water. For example, plumes appeared over northern hemisphere regions such as east of Arabia Terra, the Nili Fossae region, and the south-east quadrant of Syrtis Major, an ancient volcano 1,200 kilometers (about 745 miles) across.

It will take future missions, like NASA's Mars Science Laboratory, to discover the origin of the Martian methane. One way to tell if life is the source of the gas is by measuring isotope ratios. Isotopes are heavier versions of an element; for example, deuterium is a heavier version of hydrogen. In molecules that contain hydrogen, like water and methane, the rare deuterium occasionally replaces a hydrogen atom. Since life prefers to use the lighter isotopes, if the methane has less deuterium than the water released with it on Mars, it's a sign that life is producing the methane.

Whatever future research reveals--biology or geology--one thing is already clear: Mars is not so dead, after all.

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