Explosive bursts of methane helped ancient Mars keep liquid water flowing, study finds

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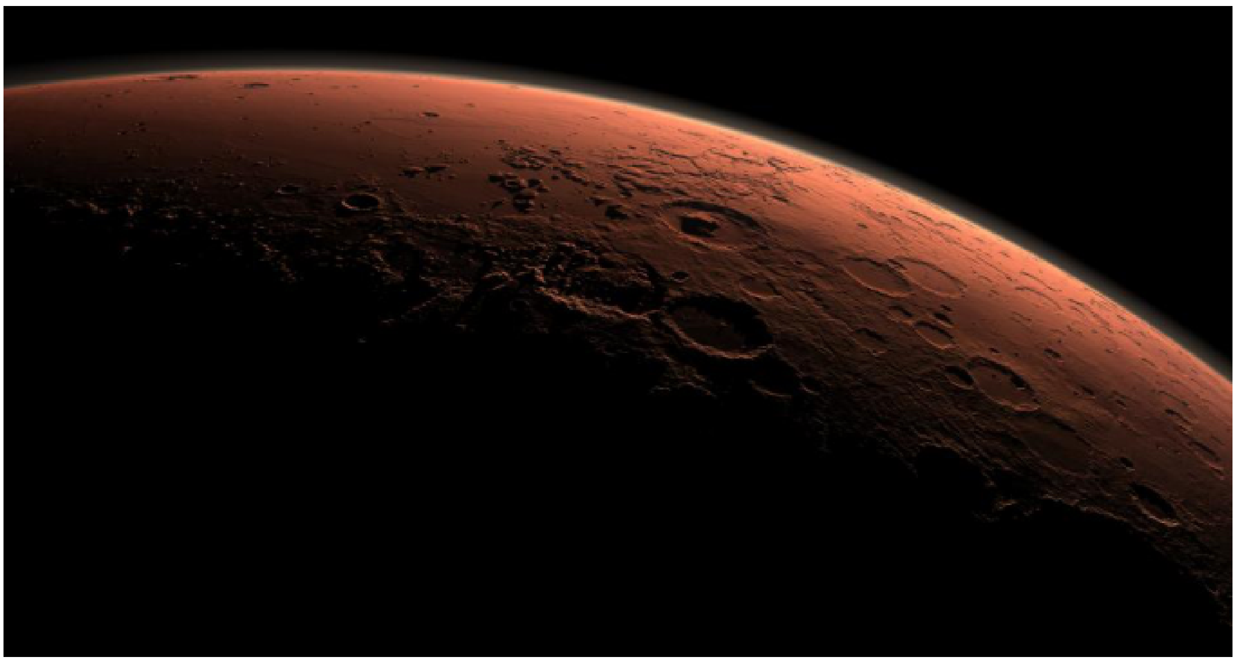

Credit: NASA

In a drying time, Mars may have been kept warm enough for liquid water to remain stable on the surface thanks to explosive bursts of methane gas, a new study finds.

The simulations, described in the journal *Nature Geoscience*, could explain how Mars managed to sustain a series of lakes in a climate that at first glance seems too cold and arid to have done so.

Since landing on the Red Planet in August 2012, NASA's rover Curiosity has discovered that 96-mile-wide Gale Crater held a series of lakes around 3.5 billion years ago. The rocks it has drilled and X-rayed and lasered have also revealed environments that would have been potentially habitable for Earth-like life.

Keep in mind, however, that Mars' wettest period was likely the first billion years of its 4.6 billion-year life, the Noachian period, when it had a thicker atmosphere that would have been better able to keep liquid water stable on the planet's surface.

"Although the climate was relatively cold compared to Earth, there is evidence that liquid water flowed in streams and rivers, formed alluvial fans and deltas, and ponded in big lakes and possibly seas," Alberto Fairen of the Centro de Astrobiologia in Spain and Cornell University, who was not involved in the paper, wrote in a commentary.

Then came the 600 million-year Hesperian period, when the Red Planet began to transform from a cold, wet world to a cold, icy one, as the protective atmosphere thinned and the planet's interior cooled. The next 3 billion years until now are known as the Amazonian period, during which Mars solidified its reputation as the cold, dry planet we see today.

So here's the thing that's puzzled planetary scientists: Gale Crater's rocks bear evidence of liquid water on Mars during the Hesperian period, including lakes (perhaps protected by a layer of surface ice) and deltas. But that means these lakes and deltas persisted during a period that was markedly drier, with a thinner atmosphere less capable of sustaining liquid water. How do these two facts square up?

"Previous hypotheses have struggled to explain lake-forming climates that are both rare and long-lasting," Fairen wrote. "For example, volcanism and impacts can produce episodes of climate warming, but not of sufficiently long duration."

Now, lead author Edwin Kite, a planetary scientist the University of Chicago, and his colleagues say that after running climate models they've come up with an explanation: explosive bursts of methane.

Here's how it works. The Red Planet's obliquity, or tilt on its axis, can vary far more dramatically than Earth's does. The researchers think that occasional dramatic shifts in that tilt (perhaps around 10 to 20 degrees) would have exposed ice-covered parts of the Martian surface to the sun, causing that cover to shrink fairly quickly. The ice's retreat would have exposed clathrates filled with pockets of methane, allowing the methane to burst out of the ground and into the atmosphere.

Methane is a powerful greenhouse gas - about 25 times as powerful as carbon dioxide. So if enough of it were to emerge from the ground at the same time, it could actually result in a significant amount of warming, the thinking goes.

Now, eventually, methane gets broken down by sunlight. But in the meantime, Kite and his colleagues found that it could lead to warming lasting hundreds of thousands of years - long enough to explain the extended presence of liquid water during this otherwise dry time in Martian history, scientists say.

What does this mean for the possibility that life could have emerged on Mars? Kite was quick to point out that if any microbes ever lived on the Red Planet, they would likely have done so during its earliest days, when water was far more abundant.

"If life ever established itself on Mars, then it would have probably done so before the relatively young (less than 3.6 billion years ago) features modeled in our paper," Kite wrote in an email.

Regardless, the study reveals an increasingly complex portrait of a planet in transition, scientists said.

"The methane burst scenario proposed by Kite et al. contributes to an emerging view that the existence of liquid water on early Mars arose from a combination of diverse astronomical, geochemical and geological factors," Fairen wrote. "Although it seems unlikely that a single mechanism can explain not only the presence of liquid water, but its recurrence and persistence, the methane burst hypothesis provides a means to episodically tip the Hesperian climate over the edge."

More information: Methane bursts as a trigger for intermittent lake-forming climates on post-Noachian Mars, *Nature Geoscience* (2017). nature.com/articles/doi:10.1038/ngeo3033