ESA's Mars orbiters did not see latest Curiosity methane burst

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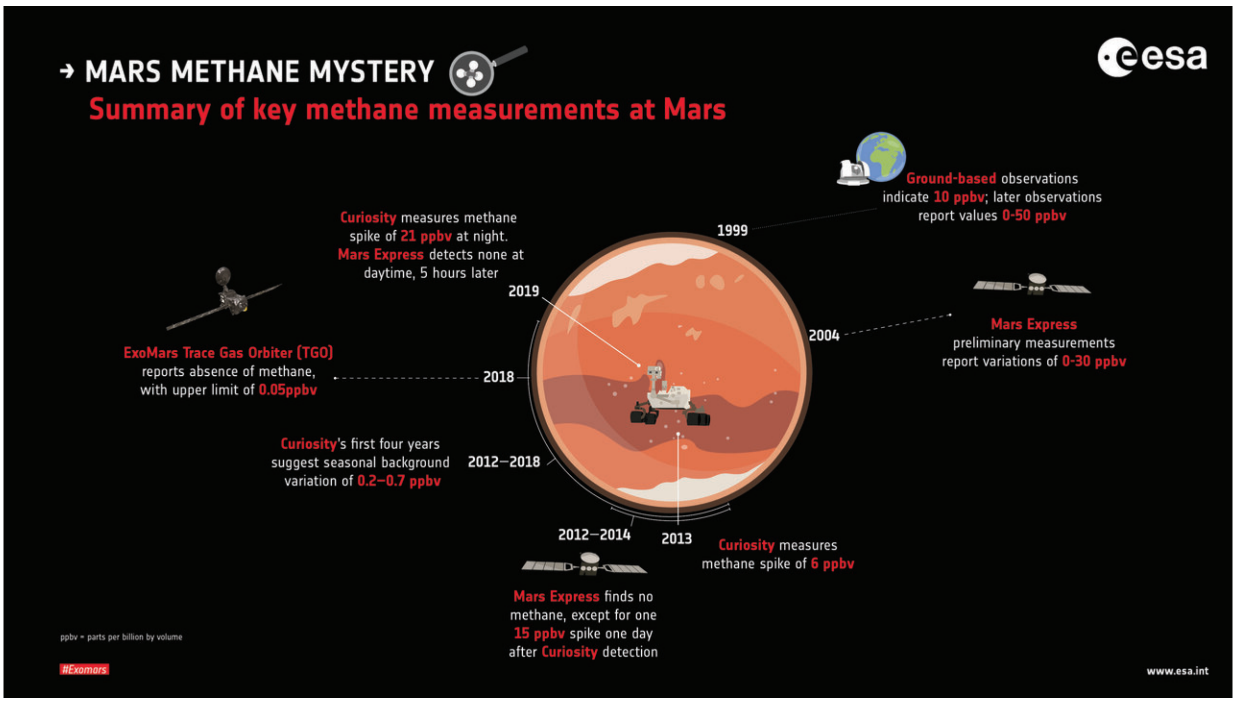


This graphic summarises significant measurement attempts of methane at Mars. Reports of methane have been made by Earth-based telescopes, ESA's Mars Express from orbit around Mars, and NASA's Curiosity located on the surface at Gale Crater; they have also reported measurement attempts with no or very little methane detected. More recently, the ESA-Roscosmos ExoMars Trace Gas Orbiter reported an absence of methane, and provided a very low upper limit. In order to reconcile the range of results, which show variations in both time and location, scientists have to understand better the different processes acting to create and destroy methane. Credit: European Space Agency

In June, NASA's Curiosity rover reported the highest burst of methane recorded yet, but neither ESA's Mars Express nor the ExoMars Trace Gas Orbiter recorded any signs of the illusive gas, despite flying over the same location at a similar time.

Methane is of such fascination because on Earth a large proportion is generated by living things. It is known that methane has a lifetime of several hundred years before it is broken down by the Sun's radiation, so the fact that it is detected on Mars suggests it has been released into the atmosphere recently—even if the gas itself was generated billions of years ago.

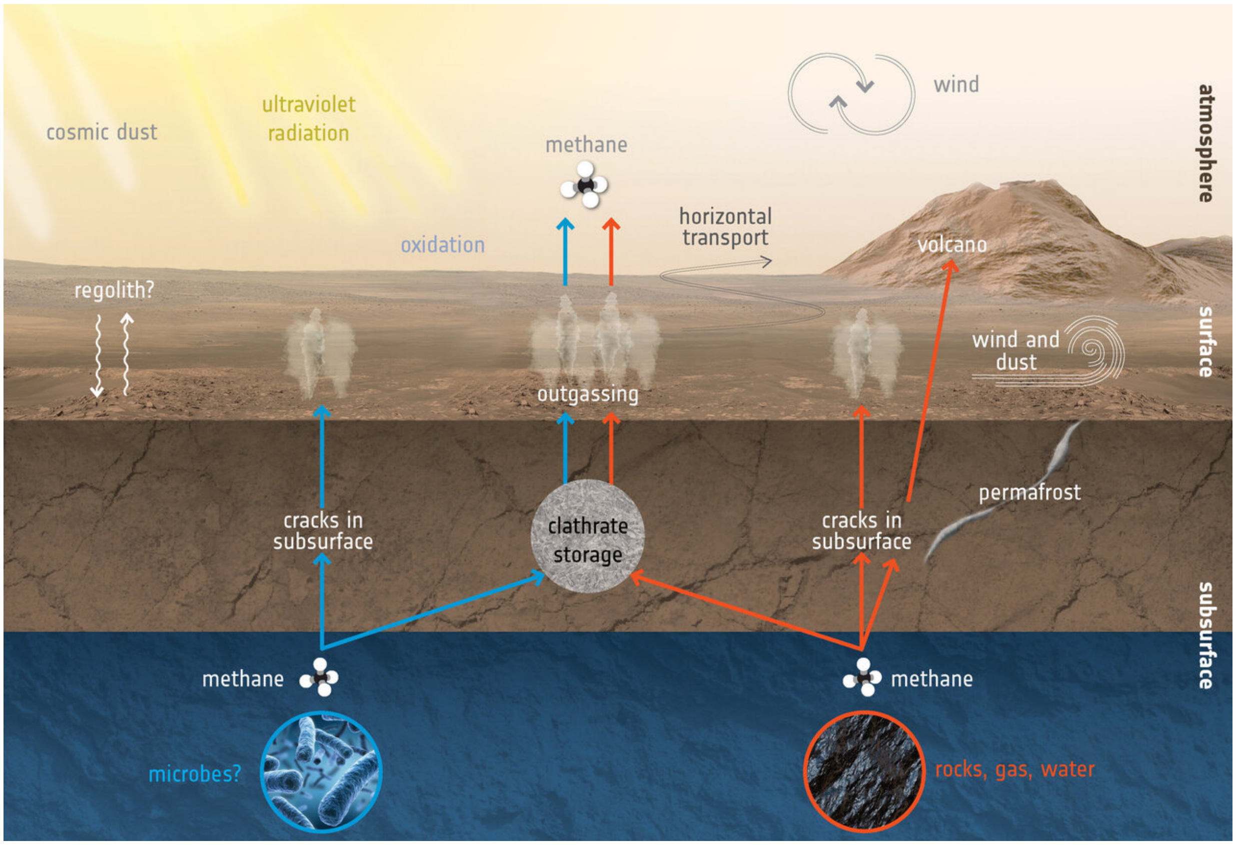
The methane mystery on Mars has had many twists and turns in recent years with unexpected detections and non-detections alike. Earlier this year it was reported that ESA's Mars Express had detected a signature that matched one of Curiosity's detections from within Gale Crater.

A recent spike by Curiosity, measured on 19 June 2019, and the highest yet at 21 ppbv, adds to the mystery because preliminary analysis suggest that Mars Express did not detect any on this occasion. (For comparison, the concentration of methane in Earth's atmosphere is around 1800 ppbv, meaning that for every billion molecules in a given volume, 1800 are methane.)

The Mars Express measurements were taken in the martian daytime about five hours after Curiosity's nighttime measurements; data collected by Mars Express over one day before also did not reveal any signatures. Meanwhile Curiosity's readings had returned to background levels when further measurements were taken in the following days.

The Mars Express measurement technique allowing data to be inferred right down to the martian surface with its limit of detection around 2 ppbv.

The ESA-Roscosmos Trace Gas Orbiter (TGO), the most sensitive detector for trace gases at Mars, also did not detect any methane while flying nearby within a few days before and after Curiosity's detection.



This graphic depicts some of the possible ways methane might be added or removed from the atmosphere. One exciting possibility is that methane is generated by microbes. If buried underground, this gas could be stored in lattice-structured ice formations known as clathrates, and released to the atmosphere at a much later time. Methane can also be generated by reactions between carbon dioxide and hydrogen (which, in turn, can be produced by reaction of water and olivine-rich rocks), by deep magmatic degassing or by thermal degradation of ancient organic matter. Again, this could be stored underground and outgassed through cracks in the surface. Methane can also become trapped in pockets of shallow ice, such as seasonal permafrost. Ultraviolet radiation can both generate methane – through reactions with other molecules or organic material already on the surface, such as comet dust falling onto Mars – and break it down. Ultraviolet reactions in the upper atmosphere (above 60 km) and oxidation reactions in the lower atmosphere (below 60 km) acts to transform methane into carbon dioxide, hydrogen and water vapour, and leads to a lifetime of the molecule of about 300 years. Methane can also be quickly distributed around the planet by atmospheric circulation, diluting its signal and making it challenging to identify individual sources. Because of the lifetime of the molecule when considering atmospheric processes, any detections today imply it has been released relatively recently. Credit: European Space Agency

In general, TGO is capable of measuring at parts per trillion levels and accessing down to about 3-kilometer altitude, but this can depend on how dusty the atmosphere is. When measurements were taken at low latitudes on 21 June 2019, the atmosphere was dusty and cloudy, resulting in measurements accessing 20-15 km above the surface with an upper limit of 0.07 ppbv.

The global lack of methane recorded by TGO is adding to the overall mystery, and corroborating the results of the different instruments is keeping all teams busy.

"Taking the results together suggests that the latest spike measured by Curiosity was very short lived—less than one martian day—and likely local," says Marco Giuranna, principal investigator for the Planetary Fourier Spectrometer onboard Mars Express that is used to detect methane.

"Curiosity measured the methane at night, and if it was released at that time, we would expect it to have been trapped near the surface until sunrise before getting rapidly mixed and transported away. As a result, there would be no chance for it to be detected by Mars Express or TGO.

"By comparison, the spike we co-measured in 2013 must have been of a longer duration or more intense at its source—which we believe was outside Gale Crater—such that it could be detected by our instrument on Mars Express as well."

The teams are continuing to look into the influence of atmospheric circulation between day and night, and if the location of Curiosity inside an impact crater plays a role. They are also studying the way that methane is destroyed, in case the gas is being absorbed by surface rocks again before it is circulated more widely into the atmosphere.

"Combining observations from the surface and from orbit with future coordinated observations will help us understand the behaviour of methane in the atmosphere, with non-detections like that from TGO providing upper limits, constraints and important context," adds Håkan Svedhem, ESA's TGO project scientist.

Provided by European Space Agency

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