The Curiosity robot confirms methane in Mars' atmosphere which may hint that existed life

February 27 2015

The Curiosity robot has detected the changes of methane on the surface of the red planet. Credit: NASA

The tunable laser spectrometer in the SAM (Sample Analysis at Mars) instrument of the Curiosity robot has unequivocally detected an episodic increase in the concentration of methane in Mars' atmosphere after an exhaustive analysis of data obtained during 605 soles or Martian days.

This has been revealed in an article authored by scientists from the MSL (Mars Science Laboratory) mission, recently published in *Science*. One of the authors of this article is Francisco Javier Martín-Torres, a researcher at the Andalusian Institute of Earth Sciences (CSIC-UGR).

This puts an end to the long controversy on the presence of methane in Mars, which started over a decade ago when this gas was first detected with telescopes from Earth. The controversy increased afterwards with the measurements obtained by orbiting satellites, some of which were occasionally contradictory. These new and incontrovertible data open paths for new research that can identify the sources that produce this gas—which could include some type of biological activity—and the mechanisms by means of which the gas is eliminated with such inexplicable speed.

Ever since the Telescope in the Mauna Kea Canada-France-Hawaii Observatory first announced the detection of methane in the Martian atmosphere, several other measurements of the gas have been conducted by means of a diversity of instruments, both remotely from earth, and also by means of satellites like the Mars Express and the Mars Global Surveyor.

Since methane can be the product of biological activity—practically all the existing methane in Earth's atmosphere originates in this way—this has created great expectations that Martian methane could also be of a similar origin.

Methane in Mars

These observations appeared to be contradictory. Some of them suggested a distribution pattern that was limited in space (with its source in the Northern hemisphere) and time (with a peak of concentration during summer in the Northern hemisphere and its subsequent vanishing

in just a matter of months). Both facts are inexplicable by available photochemical and general circulation models, which are currently used to define our understanding of Martian atmosphere.

According to these models, if there really existed methane in Mars, it would remain there for an average 300 years, and during this period it would be homogeneously distributed across the atmosphere. Since we lack a model that can account for its generation, localization and swift disappearance, detections were all called in doubt, and the results were attributed to the instruments employed in their detection, which were working on the very limit of their capacity, and also to the fact that the concentration values of the gas that they yielded were of the ppbv order (parts per billion by volume).

"Within this context, and when we were all almost fully persuaded that the data we had so far collected were at the very least rough it not fully invalid, the expectations to decide on this were bestowed upon the capacity of the SAM instrument to come up with more precise measurements", says this researcher at the Andalusian Institute of Earth Sciences.

By means of its TLS unit, SAM has been detecting basal levels of methane concentration of around 0,7 ppbv, and has confirmed an event of episodic increase of up to ten times this value during a period of sixty soles (Martian days), i.e., of about 7 ppvb.

The new data are based on observations during almost one Martian year (almost two Earth years), included in the initial prediction for the duration of the mission (nominal mission), during which Curiosity has surveyed about 8 kms in the basin of the Gale crater.

Martian seasons

During this period, which comprehends all the full cycle of Martian seasons, the reference to the environmental data collected by the meteorological REMS (Rover Environmental Monitoring Station) station has allowed for the establishment of possible correlations with the environmental parameters that this instrument records: relative humidity, temperature and atmospheric opacity. Data on atmospheric opacity was obtained both by the UV sensor in REMS and also by MastCam (Mast Camera), the camera at Curiosity, which is employed for support in atmospheric surveys.

REMS is an instrument that has been developed and it is being scientifically exploited by Spanish researchers, some of whom have been members of the team that has conducted this important research. The hypothetical existence of seasonal variations in methane concentration in correlation with certain environmental variables, in any case, will be only confirmed through sustained measurements in the future, specifically oriented to establish which factors can determine the sporadic emission and subsequent degradation of this gas in Mars. As far as the spatial disposition of the methane plumes, they have concluded that they are generated in very brief and weak events and in very specific places.

TLS is a two-channel tunable laser spectrometer which analyses in the infrared region—more specifically in a 2,7 μm wavelength through the first channel, and 3,27 μm through the second. The latter channel is specifically prepared for the detection of methane. It has a resolution of 0,0002 cm-1, which allows for the detection of methane through its spectrographic footprint of three very clearly defined lines, and the procedure which is applied (laser light absorption through a sample contained in a closed cell) "is simple, non-invasive and sensitive" as the article itself claims.

Small margin of error

The containing cell can be full of Martian environment or as a vacuum to make contrasting measurements, which include some conducted through artificially increased concentrations, "which has resulted in a very reduced margin for error and guarantees the accuracy of results, which can now be deemed definitively conclusive", says Martín-Torres.

According to him, the new questions posed by these results far outnumber the answers it does provide. "It is a finding that puts paid to the question of the presence of methane in the Martian atmosphere, but it does pose some other more complex and far-reaching questions, such as the nature of its sources—which must lie, we believe, in one or two additional sources that were not originally contemplated in the models used so far. Among these sources, we must not rule out biological methanogenesis. Another new question is related to the bizarre evolution of methane in the Martian atmosphere after its emission. Both questions should be addressed in the future with specifically designed new research."

The newly arrived MAVEN (Mars Atmosphere and Volatile Evolution) from NASA will immediately provide continuity for the study of this subject, and in the near future the Trace Gas Orbiter (TGO), jointly developed by the European Space Agency (ESA) and the Russian Space Agency (Ruscosmos), which is also part of the ExoMars mission, will measure the concentration of methane at larger scale, and it will allow for the establishment of a framework to contextualize the results obtained, and deepen our knowledge of methane dynamics in Mars.

Provided by University of Granada