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JPL Briefing on Methane on Mars measured by Curiosity

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The briefing on 2 November 2012, talking about the methane measured by Curiosity in the last few weeks, had the following participants:

Michael Meyer, NASA Headquarters, Washington; Mars Science Laboratory Program Scientist, and Lead Scientist for NASA Mars Exploration Program

Paul Mahaffy, NASA Goddard Space Flight Center, Greenbelt, Md.; Principal Investigator for Sample Analysis at Mars (SAM) on Curiosity

Chris Webster, NASA Jet Propulsion Laboratory, Pasadena, Calif.; Instrument Lead for SAM Tunable Laser Spectrometer (TLS)

Sushil Atreya, University of Michigan, Ann Arbor; Co-investigator for SAM

Laurie Leshin, Rensselaer Polytechnic Institute, Troy, N.Y.; Co-investigator for SAM and for Alpha Particle X-Ray Spectrometer on Curiosity

Paul Mahaffy talked about the SAM instrument. Paul started with a bit of history and how methane could be locked up on the soil of Mars from ancient times.

Lifting SAM Instrument for Installation into Mars Rover

The Sample Analysis at Mars (SAM) instrument, largest of the 10 science instruments for NASA's Mars

Science Laboratory mission, will examine samples of Martian rocks, soil and atmosphere for information about chemicals that are important to life and other chemical indicators about past and present environments.

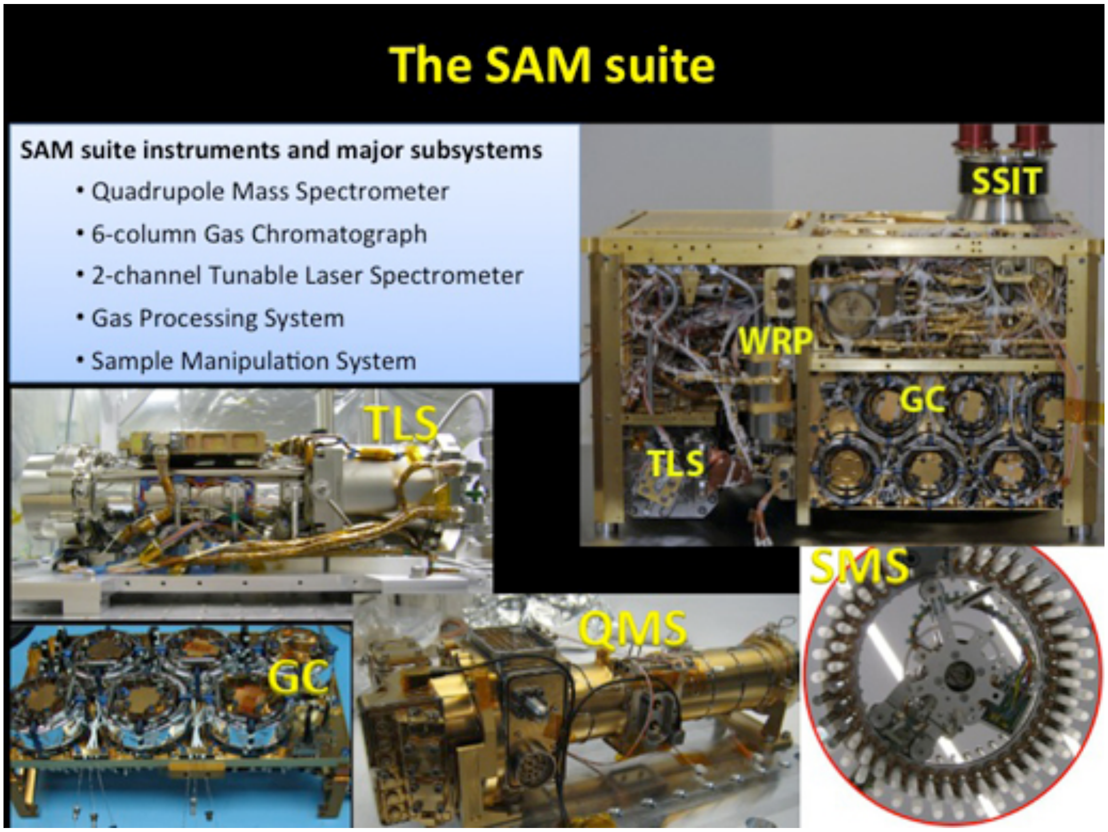
NASA's Goddard Space Flight Center, Greenbelt, Md., built SAM. The 40-kilogram (88-pound) instrument includes three laboratory tools for analyzing chemistry, plus mechanisms for handling and processing samples.

In this photograph, technicians and engineers inside a clean room at NASA's Jet Propulsion Laboratory, Pasadena, Calif., prepare to install SAM into the mission's Mars rover, Curiosity. The photograph was taken on Jan. 6, 2011.

The analytical tools in SAM are a mass spectrometer built by NASA Goddard, a gas chromatograph built by French partners supported by France's national space agency in Paris, and a laser spectrometer built by JPL. SAM's sample manipulation system, including 74 sample cups for carrying powdered samples to two ovens, was built by Honeybee Robotics, New York. Curiosity's robotic arm will deliver powdered samples, drilled from rocks or scooped from soil, to SAM's inlet tubes on top of the rover deck. Ovens will heat most samples to about 1,000 degrees Celsius (about 1,800 degrees Fahrenheit). SAM will take in atmospheric samples through separate ports on the side of the rover. Inside SAM are more than 600 meters (more than 650 yards) of wiring, 52 microvalves, a saft-drink-can-size pump that rotates 100,000 times per minute, and many other components.

NASA will launch Curiosity from Florida between Nov. 25 and Dec. 18, 2011, together with other parts of the Mars Science Laboratory spacecraft for delivering the rover to the surface of Mars in August, 2012. During a prime mission lasting one Mars year (two Earth years), researchers will use the rover in one of the most intriguing areas of Mars to investigate whether conditions there have been favorable for microbial life and favorable for preserving evidence about whether life has existed.

JPL, a division of the California Institute of Technology in Pasadena, manages the Mars Science Laboratory mission for the NASA Science Mission Directorate, Washington.



The SAM Suite

The Sample Analysis at Mars (SAM) instrument, largest of the 10 science instruments for NASA's Mars Science Laboratory mission, examines samples of Martian rocks, soil and atmosphere for information about chemicals that are important to life and other chemical indicators about past and present environments.

SAM is in fact a suite of three different instruments supported by a complex set of components to process gases and solids. The instruments are: Quadrupole Mass Spectrometer (QMS), Tunable Laser Spectrometer (TLS), and Gas Chromatograph (GC).

Other components include: a sample manipulation system (SMS) with 74 cups; two solid sample inlet tubes (SSIT); two turbomolecular wide-range pumps (WRP); two ovens to release gas to SAM's instruments; 14 gas processing manifolds; two high conductance valves; 52 micro-valves; 51 gas line heaters; combustion and calibration gases; two scrubbers and two getters; four hydrocarbon traps; two helium tanks; four reflux heat pipes; an electronics stack consisting of eight separate modules; about 20 feet (600 meters) of harness wire; two gas inlets; and two vents to Curiosity's exterior.

The SAM instrument was developed at NASA Goddard Space Flight Center, Greenbelt, Md., with instrument contributions from NASA's Jet Propulsion Laboratory in Pasadena, Calif., and the University of Paris, France, collaborators.

Paul explained how SAM is run on Mars: a script is written, send to SAM and then executed. From which we gain our measurements send back to us on Earth.

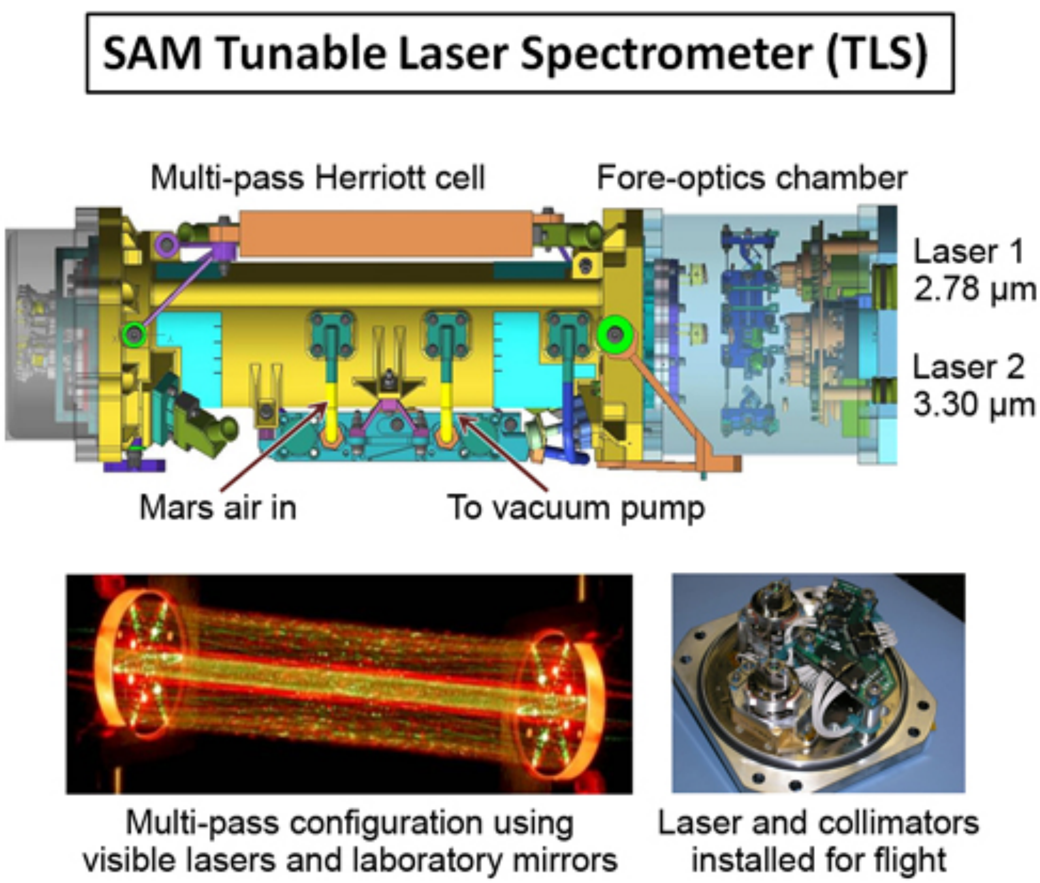
Chris Webster talked about the SAM TLS (Tunable Laser Spectrometer) and how it works.

He started by telling us that this machine is used all over Earth for many reasons. TLS has incredible high colour resolution compared to instruments looking at Mars from Earth or even from Mars-orbit. We have databases with the exact colour schemes of each element that we might encounter on Mars. CO2 isotope ratios are known and so we know what we should see on Mars. This way we know whether our instruments works correctly.

Chris told us how it was operated on Mars. They pumped the cell out, filled it again and pumped it out again. The real question is ofcourse from the audience at large : did you see Methane on Mars.

And how much methane did we see. We did measurements during the night. We then did not see Methane. We did see methane when we had pumped the cell out as it had come to Mars with SAM. But no methane since.

It surprises me that we would only look for methane at night. I would think that methane sinks would gass out their content more readily when sun warmth is warming the soil above them.

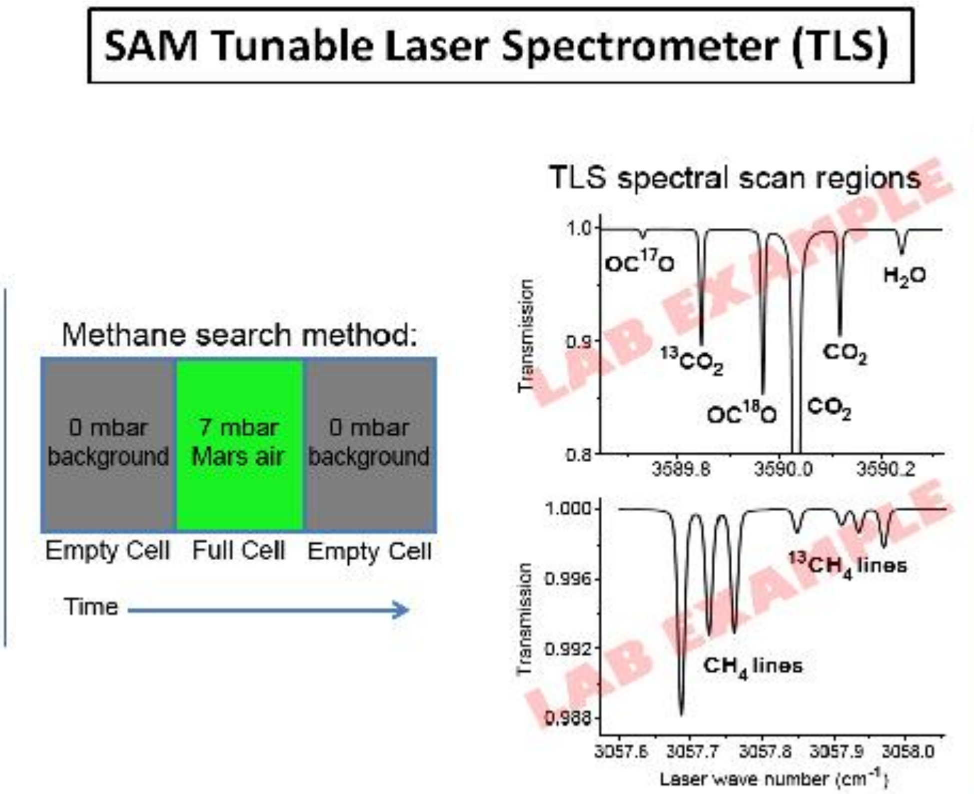


Pieces of the Tunable Laser Spectrometer

This schematic shows pieces of the Tunable Laser Spectrometer instrument, one of three instruments in the Sample Analysis at Mars instrument suite on NASA's Curiosity rover. As seen in the top graphic, the Tunable Laser Spectrometer has two infrared lasers whose light is invisible to the human eye. From the fore-optics chamber, they shoot beams into a type of measurement chamber called a multi-pass Herriot cell (shown in yellow in the middle). Mars air is pumped into this cell and out again with a vacuum pump. A detector, seen on the left of the graphic in gray, picks up the way these lasers are absorbed by the Martian air. By this method, scientists can measure concentrations of methane, carbon dioxide and water vapor and different isotopes of those gases.

At bottom left is a picture of a lab demonstration of the measurement chamber with visible lasers so scientists can see how they bounce between the mirrors in the chamber.

At bottom right is the flight hardware showing the lasers and the plate to which they are mounted. Also visible are the collimators, which are lenses that direct the lasers into the cell



Lab Examples of Tunable Laser Spectrometer Data

These graphics show how the Tunable Laser Spectrometer (TLS) instrument works and what kinds of data it returns. The TLS is one of the three instruments in the Sample Analysis at Mars instrument suite on NASA's Curiosity rover.

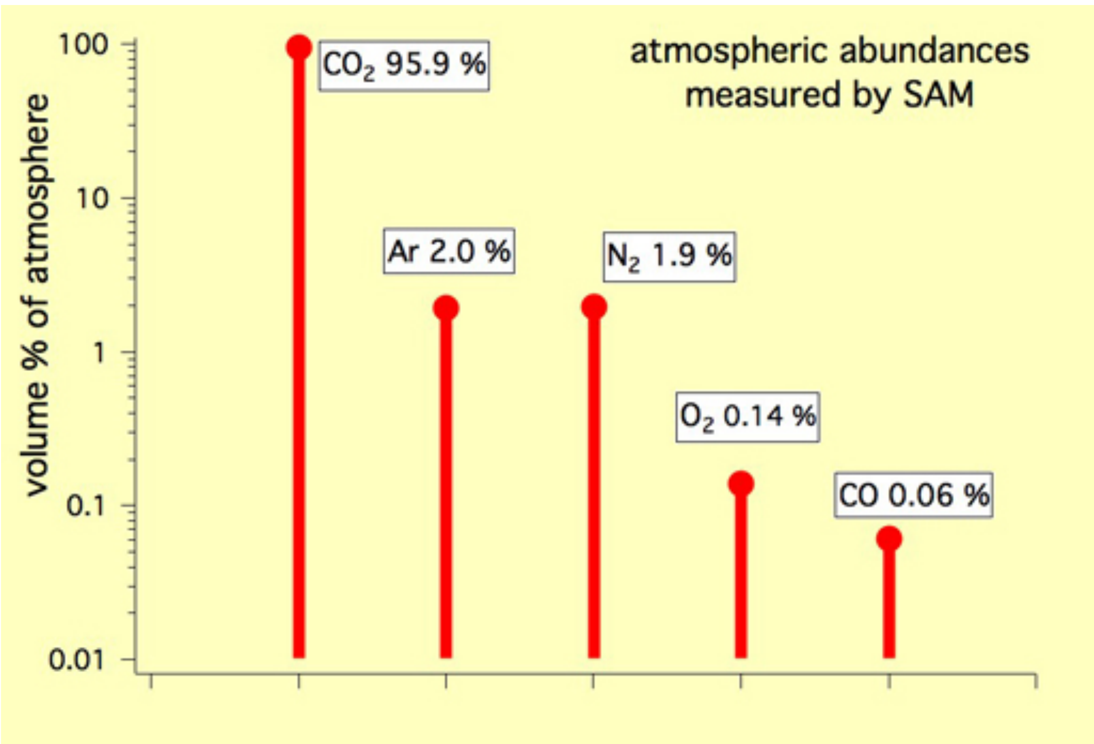
The schematic on the left shows how at the beginning of each TLS sample analysis, the chamber is emptied of air so that it is a vacuum. Then, it is filled with Martian air, which has an atmospheric pressure of 7 millibars, or seven-thousandths of the sea level air pressure of Earth. Then, after an analysis is done with the TLS lasers, the chamber is emptied again.

On the right are laboratory examples of what different isotopes of carbon dioxide, water and methane would look like in TLS data. Each isotope leaves a particular signature in the data.

Sushil Atreya explained that gasses measured on Earth change with the seasons on Earth.

On Earth methane most methane is biological in origen. We have no readings of Methane on Mars as of yet. We might have those in future. We need to know how methane is destroyed on Mars. On earth it is sunlight that destroyes methane as it changes it into other gasses. Perhaps Mars has different ways of destroying Methane.

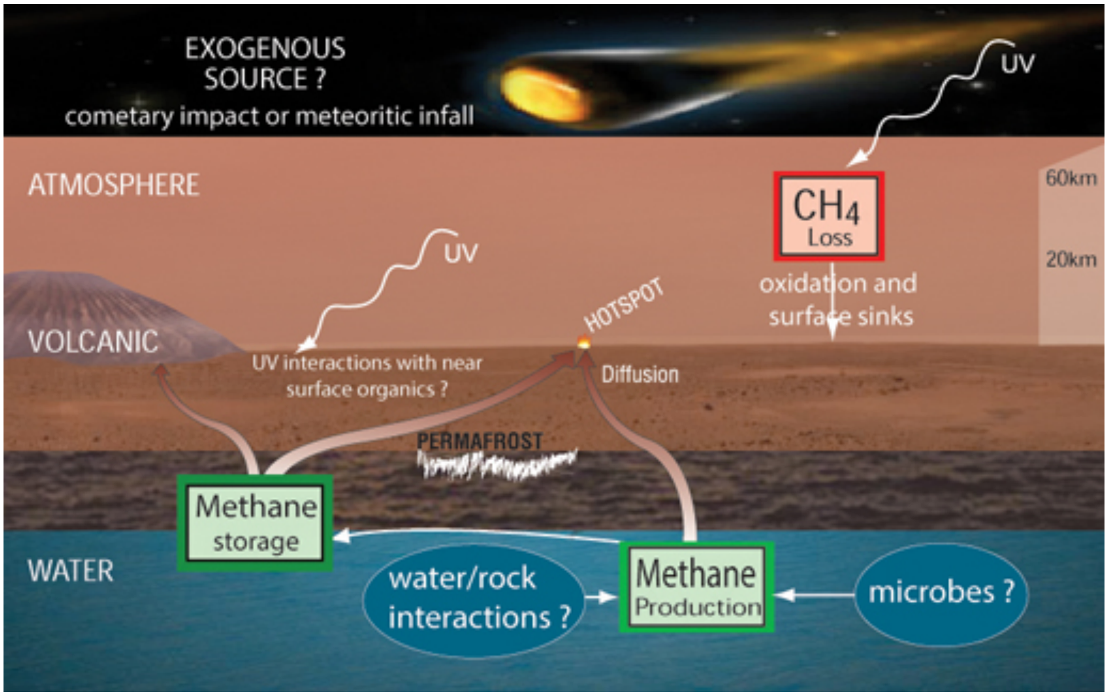
Sushil ended his account saying that the story of methane has just begun, stay tuned.



The Five Most Abundant Gases in the Martian Atmosphere

This graph shows the percentage abundance of five gases in the atmosphere of Mars, as measured by the Quadrupole Mass Spectrometer instrument of the Sample Analysis at Mars instrument suite on NASA's Mars rover in October 2012. The season was early spring in Mars' southern hemisphere, and the location was inside Mars' Gale Crater, at 4.49 degrees south latitude, 137.42 degrees east longitude.

The graph uses as logarithmic scale for volume percentage of the atmosphere so that these gases with very different concentrations can all be plotted. By far the predominant gas is carbon dioxide, making up 95.9 percent of the atmosphere's volume. The next four most abundant gases are argon, nitrogen, oxygen and carbon monoxide. Researchers will use SAM repeatedly throughout Curiosity's mission on Mars to check for seasonal changes in atmospheric composition.



Potential Sources and Sinks of Methane on Mars

If the atmosphere of Mars contains methane, various possibilities have been proposed for where the methane could come from and how it could disappear.

Potential non-biological sources for methane on Mars include comets, degradation of interplanetary dust particles by ultraviolet light, and interaction between water and rock. A potential biological source would be microbes, if microbes have ever lived on Mars. Potential sinks for removing methane from the atmosphere are photochemistry in the atmosphere and loss of methane to the surface.

Laurie Leshin talked about the methane on Mars; the atmosphere lost to space, and the story of water on mars.

The story of the atmosphere of Mars is the story of the history of Mars over the last 4,500 million years.

Gasses have isotopes that tell us how they were formed. Water is important in the story of Methane. Isotope traces can tell us what has happened. Atmosphere escape would mean heavier isotopes stay behind while the lighter isotopes get lost to Space.

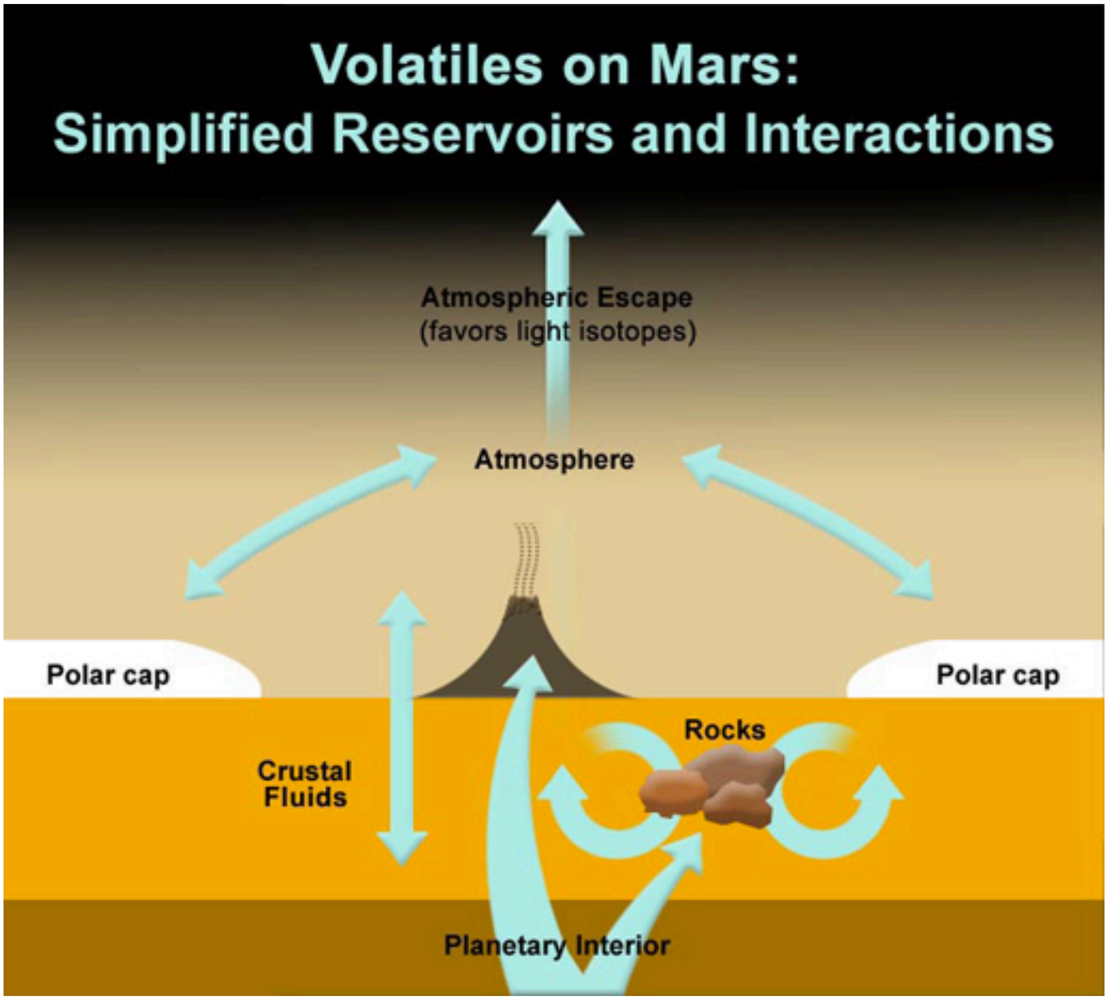
Here is what we found with SAM:

Carbon Dioxide is 5% enriched with heavier isotopes relatively speaking.

We looked at the two most abundant isotopes of Argon. Argon is not reactive and just shows the history of the atmosphere. The ratio is about a factor 7 higher than Earth which tells us that the argon escaped to Space from the Martian atmosphere.

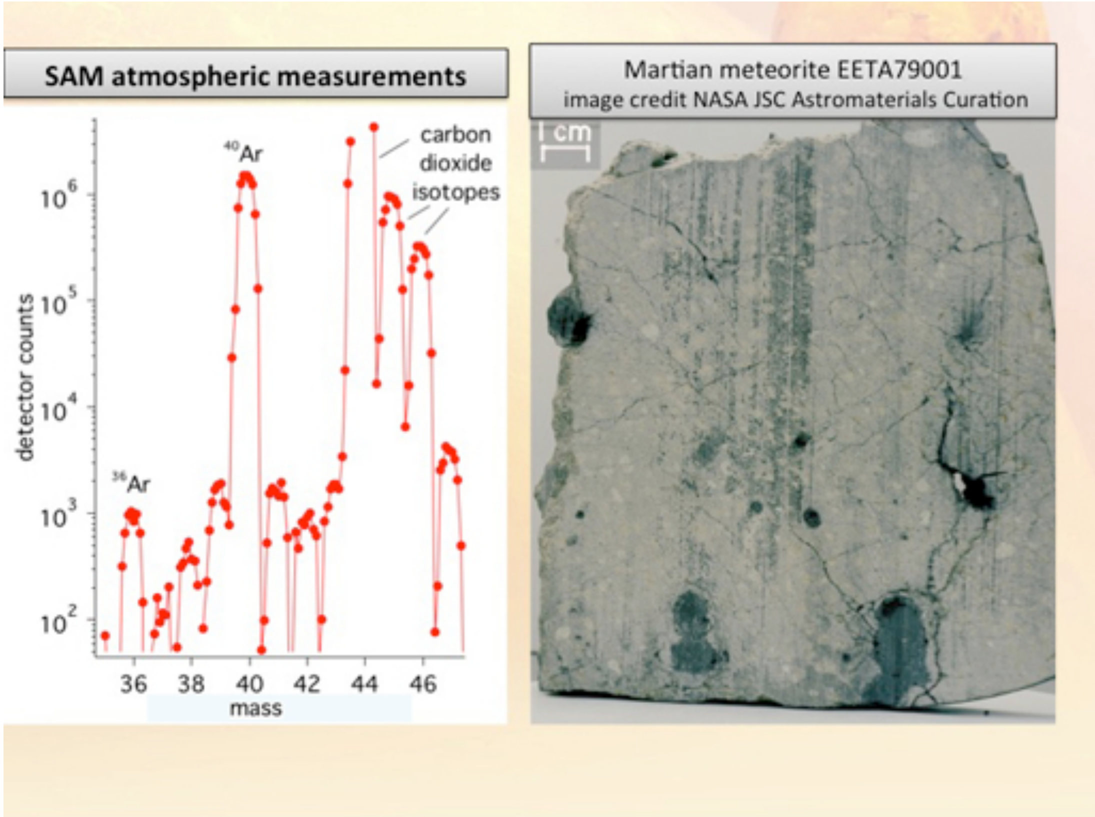
What is important: the gasses in the glass blobs is Mars Meteorites are exactly the same in this respect. They confirm that these rocks are indeed samples of Mars.

We are going to do measurements with concentrations of gasses in the atmosphere. We also are going to compare them with measurements by SAM of the composition of rocks on Mars.



This illustration shows the locations and interactions of volatiles on Mars. Volatiles are molecules that readily evaporate, converting to their gaseous form, such as water and carbon dioxide. On Mars, and other planets, these molecules are released from the crust and planetary interior into the atmosphere via volcanic plumes. On Mars, significant amounts of carbon dioxide go back and forth between polar ice caps and the atmosphere depending on the season (when it's colder, this gas freezes into the polar ice caps).

New results from the Sample Analysis at Mars, or SAM, instrument on NASA's Curiosity rover show that the lighter forms of certain volatiles, also called isotopes, have preferentially escaped from the atmosphere, leaving behind a larger proportion of heavy isotopes. Scientists will continue to examine this phenomenon as the mission continues, looking for isotope signatures in rocks. One question they plan to address is: To what degree have atmospheric volatiles been incorporated into rocks in the crust through the action of fluids, perhaps in the distant past?



Bottom line of this briefing: NO methane measurements on Mars by SAM as yet.

However SAM did confirm our mars meteorites are really from Mars.

The following is a write up of the questions and answers after the briefing.

Temporal nature of the emissions of Methane is going to be looked into. Seasonal differences could be observed.

Even as far as 5 parts per billion there is no methane measured. The team says we will see what Mars will tell us.

What did they do to get their results ?

They pumped the cell down to 7 millibars pressure and then saw an increase of methane over time. That troubled them. They then suspected that this was due to leakage from the main casing into the cell, and that this 7 or 8 parts per billion of methane they measured was actually something they brought from Earth with the instruments and that this methane leaked into the call.

Paul Mahaffy told that 4 runs of measurements of SAM were done. After two measurements they decided to pump the pressure down to 7 millibars and to concentrate on the TLS experiment. They looked for trend, but did not find it.

Paul tells us that they plan to concentrate the atmosphere of Mars to measure inside SAM. However there are many instruments on Curiosity and this would take time from other instruments that also wants to be used.

They are talking about the break down of methane and how that could be different on Mars. This part of the discussion is kind of baffling to me as this talk is totally superfluous as they have not measured any martian methane, or so they say. So unless they are confident that they are going to measure methane during the Curiosity mission it makes no sense why they would want to ponder the question of how methane is destroyed more quickly on Mars. e.g. by the dust devils and their electric currents destroying methane in the atmosphere.

What could the source of the methane be is one of the questions put forward by reporters. The answer: any source could be it.

German reporter asks whether other instruments on Curiosity could help in determining where methane would come from if measured on Mars. The answer is that indeed the measurements of rocks and minirals in them could give answers. Ultraviolete radiation working on organics coming to Mars with meteorites might destroy them.

Were there any model experiments built to explain the 50 parts per billion of methane which were measured by Mars Express Fourien Planetary Spectrometer. They were done, and the results of that were all over the spectrum.

Paul Mahaffy we have done these on testbeds in laboratories

Paul Mahaffy : we are scanning 500 daltons in the atmosphere. Laurie tells us that only the TLS is tuned to find methane.

How are the temperatures on Mars. Are they higher then expected? On the Curiosity we indeed measured higher temperatures and that was something that made us happy as our instruments like higher temperatures.

The loss of atmosphere can also be measured by looking into the water on Mars, and the other noble gasses and ofcourse by looking into the minerals in the rocks. All these will tell us how much atmosphere of Mars was lost to Space.

Author: artemis

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